MEDICO-CHIRURGICAL TRANSACTIONS,

8584

PUBLISHED BY THE

ROYAL

MEDICAL AND CHIRURGICAL SOCIETY

OF

LONDON.

VOLUME THE TWENTY-NINTH.

LONDON:

PRINTED FOR LONGMAN, BROWN, GREEN, AND
LONGMANS, PATERNOSTER-ROW.

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RICHARD KINDER, PRINTER,
GREEN ARBOUR COURT, OLD BAILEY

ROYAL
MEDICAL AND CHIRURGICAL SOCIETY
OF LONDON.

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FOR THE SESSION OF 1845-6.

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WATSON, THOMAS, M.D.
WILSON, JAMES ARTHUR, M.D.

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ELECTED.

1805. WILLIAM SAUNDERS, M.D.
1808. MATTHEW BAILLIE, M.D.
1810. SIR HENRY HALFORD, Bart., G.C.H.
1813. SIR GILBERT BLANE, Bart.
1815. HENRY CLINE.
1817. WILLIAM BABINGTON, M.D.
1819. SIR ASTLEY PASTON COOPER, Bart., K.C.H., D.C.L.
1821. JOHN COOKE, M.D.
1823. JOHN ABERNETHY.
1825. GEORGE BIRKBECK, M.D.
1827. BENJAMIN TRAVERS.
1829. PETER MARK ROGET, M.D.
1831. WILLIAM LAWRENCE.
1833. JOHN ELLIOTSON, M.D.
1835. HENRY EARLE.
1837. RICHARD BRIGHT, M.D.
1839. SIR BENJAMIN COLLINS BRODIE, Bart.
1841. ROBERT WILLIAMS, M.D.
1843. EDWARD STANLEY.
1845. WILLIAM F. CHAMBERS, M.D., K.C.H.

FELLOWS

OF THE

ROYAL MEDICAL AND CHIRURGICAL SOCIETY OF LONDON.

EXPLANATION OF THE ABBREVIATIONS.

P.—President.	V. P.—Vice-President.
T.—Treasurer.	S.—Secretary.
L.—Librarian.	C.—Member of Council.

AUGUST 1846.

Amongst the non-residents, those marked thus (*) are entitled by composition to receive the Transactions.

ELECTED

1841 *James Abercrombie, M.D., *Cape of Good Hope.*

1846 John Abercrombie, M.D., *Physician to the Public Dispensary, Lincoln's-inn;* 13, *Old Bond-street.*

1842 William Acton, *Surgeon to the Islington Dispensary;* 46, *Queen Anne-street, Cavendish-square.*

1818 Walter Adam, M.D., *Physician to the Royal Public Dispensary, Edinburgh.*

1818 Thomas Addison, M.D., *Physician to, and Lecturer on Medicine at, Guy's Hospital;* 24, *New-street, Spring-gardens.* C. 1826. V. P. 1837.

1814 Joseph Ager, M.D., *Great Portland-street.* C. 1836.

1819 *James Ainge, *Fareham, Hants.*

1837 *Ralph Fawsett Ainsworth, M.D., 104, *King-street, Manchester.*

ELECTED

1819 George F. Albert.

1839 Rutherford Alcock, K.C.T., K.T.S., *China.*

1826 James Alderson, M.D., F.R.S., 36, *Charles-street, Berkeley-square.*

1843 C. J. B. Aldis, M.D., *Physician to the London and Surrey Dispensaries, and Lecturer on Medicine at the Charlotte-street School of Medicine;* 46 B, *Chester-square.*

1813 Henry Alexander, *Surgeon-Oculist in Ordinary to the Queen, and Surgeon to the Royal Infirmary for Diseases of the Eye;* 6, *Cork-street.* C. 1840.

1836 Henry Ancell, *Surgeon to the Western General Dispensary;* 3, *Norfolk-crescent, Oxford-square.*

1817 Alexander Anderson.

1816 John Goldwyer Andrews, *Surgeon to the London Hospital;* 4, *St. Helen's-place.* C. 1836. V.P. 1840.

1820 Thomas F. Andrews, M.D., *Norfolk, Virginia.*

1813 William Ankers, *Knutsford.*

1819 Professor Antommarchi, *Florence.*

1818 William Withering Arnold, M.D., *Physician to the Infirmary and Lunatic Asylum, Leicester.*

1825 Thomas Graham Arnold, M.D., *Stamford.*

1819 James M. Arnott, F.R.S., *Surgeon to, and Lecturer on Surgery at, the Middlesex Hospital; New Burlington-street.* L. 1826. T. 1835. V.P. 1832. C. 1846.

1828 Neil Arnott, M.D., F.R.S., *Physician Extraordinary to the Queen; Bedford-square.* C. 1835.

1817 John Ashburner, M.D., M.R.I.A., *Physician-Accoucheur to the Queen Charlotte's Lying-in Hospital, and Physician-Accoucheur to the Middlesex Hospital;* 13, *North Audley-street.* C, 1821.

1841 John Avery, *Surgeon to the Charing Cross Hospital;* 17, *Saville-row.*

1825 Benjamin Guy Babington, M.D., F.R.S., VICE-PRESIDENT, *Physician to Guy's Hospital, and Physician to the Deaf and Dumb Institution;* 31, *George-street, Hanover-square.* C. 1829. V.P. 1845.

ELECTED

1846 C. S. Metcalfe Babington, *Surgeon-Accoucheur to the Pimlico Dispensary;* 2, *Chester-street, Belgrave-square.*

1819 John Carr Badeley, M.D., *Chelmsford.*

1820 *John H. Badley, *Dudley.*

1838 Francis Badgley, M.D., *Montreal, Upper Canada.*

1840 William Bainbridge, *Upper Tooting.*

1836 Andrew Wood Baird, M.D., *Ipswich.*

1816 *William Baker, M.D., *Physician to the Derbyshire General Infirmary; Derby.*

1839 T. Graham Balfour, M.D., *Grenadier Guards, Army and Navy Club, St. James's-square.*

1837 William Baly, M.D., *Physician to the General Penitentiary, Millbank, and Lecturer on Forensic Medicine at St. Bartholomew's Hospital;* 28, *Spring-gardens.* C. 1845.

1833 Thomas Alfred Barker, M.D., *Physician to St. Thomas's Hospital; Grosvenor-street.* C. 1844.

1843 Thomas Herbert Barker, *Priory-terrace, Bedford.*

1843 Christopher Hewetson Barnes, E.I.C.S.; *Belle-Vue House Notting-hill.*

1815 *John Baron, M.D., *Cheltenham.*

1840 Benjamin Barrow, *Liverpool.*

1844 William R. Basham, M.D., *Physician to, and Lecturer on Materia Medica at, the Westminster Hospital; Chester-street, Grosvenor-place.*

1836 William Beaumont, *Professor of Surgery in the University of King's College; Toronto, Upper Canada.*

1841 George Beaman, 32, *King-street, Covent-garden.*

1840 Charles Beevor, *Surgeon to the St. Marylebone Dispensary;* 49, *Berners-street.*

1818 *Joseph Bell, *Surgeon to the Royal Infirmary; Edinburgh.*

1819 Thomas Bell, F.R.S., L.S., and G.S., *Lecturer on Diseases of the Teeth, at Guy's Hospital;* 17, *New Broad-street.* C. 1832.

1845 Edward Unwin Berry, *James-street, Covent-garden.*

1820 Stephen Bertin, *Paris.*

ELECTED

1818 John Jeremiah Bigsby, M.D., *Newark, Nottinghamshire.*

1827 William Birch, *Barton, Lichfield.*

1845 Golding Bird, M.D., F.R.S., *Assistant-Physician to, and Lecturer on Materia Medica at, Guy's Hospital; Myddelton-square.*

1835 James Bird, 16, *Orchard-street, Portman-square.*

1846 Hugh Birt, *Morro Velhio, Minus Quœes, Rio Janeiro, Brazil; Surgeon to the Morro Velhio Hospital.*

1812 Adam Black, M.D., 114, *Piccadilly.*

1843 Patrick Black, M.D., *Assistant-Physician to St. Bartholomew's Hospital, and Physician to the Seamen's Hospital; Bedford-square.*

1844 Thomas Blackall, M.D., *Physician to the Pimlico Dispensary; Queen-street, May-fair.*

1839 Richard Blagden, *Surgeon-Accoucheur, and Surgeon Extraordinary, to the Queen; Surgeon in Ordinary to Her Royal Highness the Duchess of Kent; Albemarle-street.*

1814 Thomas Blair, M.D., *Physician to the Sussex County Hospital; Brighton.*

1841 James Blake, 16, *Pall-mall.*

1840 Peyton Blakiston, M.D., F.R.S., *Birmingham.*

1845 Henry Blenkinsop, *Warwick.*

1811 *Henry C. Boisragon, M.D., *Cheltenham.*

1823 Louis Henry Bojanus, M.D., *Wilna.*

1816 Hugh Bone, M.D., *Inspector-General of Hospitals.*

1810 John Booth, M.D., *Physician to the General Hospital at Birmingham.*

1846 John Ashton Bostock, *Scots Fusileer Guards.*

1846 Peter Bossey, *Surgeon to the Hulks at Woolwich; Thomas-street, Woolwich.*

1841 William Bowman, F.R.S, *Assistant-Surgeon to King's College Hospital, and to the Royal Ophthalmic Hospital, Moorfields;* 14, *Golden-square.*

1844 Robert Brandon.

1814 Richard Bright, M.D., F.R.S., *Physician Extraordinary to the*

ELECTED

Queen, and Consulting Physician to Guy's Hospital; Saville-row. C. 1821. V. P. 1827. P. 1837.

1813 Sir Benjamin Collins Brodie, Bart., F.R.S., *Serjeant-Surgeon to the Queen, Surgeon in Ordinary to His Royal Highness Prince Albert, Foreign Correspondent of the Institute of France, and Foreign Associate of the Royal Academy of Medicine of Paris; Saville-row.* C. 1814. V. P. 1816. P. 1839.

1844 Charles Brooke, *Keppel-street, Russell-square.*

1842 Charles Blakely Brown, M.B., *Physician-Accoucheur to the St. George's and St. James's Dispensary;* 38, *Hill-street, Berkeley-square.*

1818 *Samuel Barwick Bruce, *Surgeon to the Forces; Ripon.*

M. Pierre Brulatour, *Surgeon to the Hospital; Bourdeaux.*

1823 B. Bartlet Buchanan, M.D.

1843 J. Charles Bucknill, M.B., *Exminster, Devonshire.*

1839 George Budd, M.D., F.R.S., *Fellow of Caius College, Cambridge; Professor of Medicine in King's College, London; Physician to King's College Hospital;* 20, *Dover-street, Piccadilly.* C. 1846.

1839 Thos. Henry Burgess, M.D., 69, *Pall-mall.*

1844 A. J. Burmester, *Aleppo.*

1833 George Burrows, M.D., TREASURER, *Physician to, and Lecturer on Medicine at, St. Bartholomew's Hospital;* 45, *Queen Anne-street.* C. 1839. T. 1845.

1820 Samuel Burrows.

1835 Henry Burton, M.D., *Physician to St. Thomas's Hospital;* 41, *Jermyn-street.* C. 1842.

1837 George Busk, *Surgeon to the Hospital-ship Dreadnought; Greenwich.*

1818 John Butter, M.D., F.R.S., F.L.S., *Physician to the Plymouth Eye Infirmary; Plymouth.*

1832 *William Campbell, M.D., *Physician to the New Town Dispensary, and Lecturer on Midwifery; Edinburgh.*

1838 *Alexander Campbell, M.D., *Bombay.*

1842 Henry Cantis, 8, *Maddox-street, Hanover-square.*

ELECTED

1839 Robert Carswell, M.D., *Physician to their Majesties the King and Queen of the Belgians; Brussels.*

1825 Harry Carter, M.D., *Physician to the Kent and Canterbury Hospital; Canterbury.*

1818 Richard Cartwright, 34, *Bloomsbury-square.*

1820 Samuel Cartwright, F R.S., *Burlington-street.*

1845 Samuel Cartwright, Jun., *Sackville-street, Piccadilly.*

1839 William Cathrow, *Weymouth-street.*

1845 William Oliver Chalk, *Nottingham-terrace, New-road.*

1818 Richard Chamberlaine, *Kingston, Jamaica.*

1816 William Frederick Chambers, K.C.H., M.D., F.R.S., PRESIDENT, *Physician to the Queen, and to the Queen Dowager;* 46, *Brook-street.* C. 1818. V. P. 1821. P. 1845.

1844 Thomas King Chambers, M.D., 1, *Hill-street, Berkeley-square.*

1837 Henry T. Chapman, *Caen, Normandy.*

1838 George Chaplin Child, M.D., *Physician to the Westminster General Dispensary;* 27, *Mortimer-street.*

1842 W. D. Chowne, M.D., *Physician to the Charing Cross Hospital;* 8, *Connaught-place West, Hyde-park.*

1827 Sir James Clark, Bart., M.D., F.R.S., *Physician to the Queen, Physician in Ordinary to His Royal Highness Prince Albert, and Consulting Physician to their Majesties the King and Queen of the Belgians; Brook-street.* C. 1830. V. P. 1832.

1839 Frederick Le Gros Clark, *Assistant-Surgeon to, and Lecturer on Descriptive and Surgical Anatomy at, St. Thomas's Hospital; Finsbury-place.*

1845 John Clark, M.D., *Staff Surgeon 2nd class;* 12, *Beaumont-street, Portland-place.*

1835 James Clayton, 3, *Percy-street, Bedford-square.*

1842 Oscar M. P. Clayton, 3, *Percy-street, Bedford-square.*

1827 John Clendinning, M.D., F.R.S., *Physician to the St. Marylebone Infirmary;* 16, *Wimpole-street.* C. 1832. S. 1834. V. P. 1840.

1835 *William Colborne, *Chippenham, Wilts.*

ELECTED

1818 Robert Cole, F.L.S., *Holybourne, Hampshire.*

1828 John Conolly, M.D., *Hanwell.*

1839 John C. Cooke, M.D., *Coventry.*

1840 *William Robert Cooke, *Burford, Oxfordshire.*

1840 Bransby Blake Cooper, F.R.S., *Surgeon to, and Lecturer on Surgery at, Guy's Hospital; New-street, Spring-gardens.* C. 1830. V. P. 1842.

1820 Benjamin Cooper, *Stamford.*

1819 George Cooper, *Brentford.*

1841 George Lewis Cooper, *Surgeon to the Bloomsbury Dispensary; 35, Keppel-street, Russell-square.*

1843 William White Cooper, *Senior Surgeon to the North London Ophthalmic Institution and to the Honourable Artillery Company; 2, Tenterden-street, Hanover-square.*

1841 Holmes Coote, *Surgeon to the North London Ophthalmic Institution; 24, Argyll-street.*

1835 George F. Copeland, *Cheltenham.*

1822 James Copland, M.D., F.R.S., *Consulting Physician to Queen Charlotte's Lying-in Hospital; 5, Old Burlington-street.* C. 1830. V. P. 1838.

1839 *Charles C. Corsellis, M.D., *Resident Physician to the Lunatic Asylum, Wakefield.*

1814 *William Cother, *Surgeon to the Infirmary, Gloucester.*

1828 William Coulson, *Surgeon to the Magdalen Hospital, Consulting Surgeon to the City Lying-in Hospital; Frederick's-place, Old Jewry.* C. 1831. L. 1832.

1836 William Travers Cox, M.D., 2, *Stanhope-place, Hyde-park.*

1817 Sir Philip Crampton, Bart., F.R.S., *Surgeon-General to the Forces in Ireland.*

1814 Stewart Crawford, M.D., *Bath.*

1841 M. A. N. Crawford, M.D., *Physician to, and Lecturer on Medicine at, the Middlesex Hospital; 62, Upper Berkeley-street, Portman-square.*

1822 Sir Alexander Crichton, M.D., F.R.S., and F.L.S., *Physician in Ordinary to their Imperial Majesties the Emperor and Dowager Empress of all the Russias.* C. 1823.

ELECTED

1837 John Farrar Crookes, 21, *Argyll-street.*

1820 John Green Crosse, M.D., F.R.S., *Surgeon to the Norfolk and Norwich Hospital.*

1812 *Henchman Crowfoot, *Beccles.*

1818 William Cuming, M.D., *Professor of Botany at the Glasgow Institution, and Surgeon to the Royal Infirmary at Glasgow.*

1837 Thomas Blizard Curling, SECRETARY, *Lecturer on Surgery at, and Assistant-Surgeon to, the London Hospital;* 37, *New Broad-street.* S. 1845.

1846 Henry Curling, Esq., *Ramsgate.*

1836 George Cursham, M.D., SECRETARY, *Physician to the Asylum for Female Orphans;* 5, *Saville-row.* S. 1842.

1822 Christopher John Cusack,

1828 Adolphe Dalmas, M.D., *Paris.*

1840 John Dalrymple, *Surgeon to the London Ophthalmic Hospital;* 56, *Grosvenor-street.*

1836 *James S. Daniel, *Ramsgate.*

1820 George Darling, M.D., 6, *Russell-square.* C. 1841.

1818 *Sir Francis Sacheverel Darwin, Knt., M.D., *Sydnope, near Matlock, Derbyshire.*

1842 Bury Irwin Dasent.

1818 Henry Davies, M.D., *Physician to the British Lying-in Hospital, Brownlow-street; Physician-Accoucheur to the Marylebone General Dispensary; Saville-row.* C. 1827.

1846 Frederick Davies, *Upper Gower-street, Bedford-square.*

1817 Thomas Davis, *Hampstead.* C. 1837.

1820 Thomas Davis, *Brook-street, Hanover-square.* C. 1843.

1818 James Dawson, *Liverpool.*

1841 Campbell De Morgan, *Assistant-Surgeon to, and Lecturer on Anatomy at, the Middlesex Hospital;* 17, *Manchester-street.*

1816 *Sir David James Hamilton Dickson, M.D., F.R.S. ED., and F.L.S., *Physician to the Fleet, and to the Royal Naval Hospital, Plymouth.*

ELECTED

1839 James Dixon, *Surgeon to the Royal London Ophthalmic Hospital, and Demonstrator of Anatomy at St. Thomas's Hospital*; 37, *Broad-street-buildings*.

1844 Robert Dickson, M.D., *Curzon-street, May-fair*.

1845 John Dodd, *Portman-street, Portman-square*.

1826 John Sommers Down, M.D., *Southampton*.

1839 Henry Pye Lewis Drew, 79, *Gower-street, Bedford-square*.

1846 John Drummond, *Bengal Medical Staff*; 16, *William-street, Lowndes-square*.

1843 Thomas Jones Drury, M.D., *Physician to the Salop Infirmary; Shrewsbury*.

1845 George Duff, M.D., 14, *Gloucester-road, Hyde-park-square*.

1845 Edward Duffin, *Langham-place, Portland-place*.

1833 William Dunbar, M.D., *Bombay*.

1833 Robert Dunn, *Norfolk-street, Strand*. C. 1845.

1843 C. M. Durrant, M.D., *Physician to the East Suffolk and Ipswich Hospital; Ipswich*.

1839 Henry Dyer, M.D., 37, *Bryanston-square*.

1836 J. W. Earle, *Cheltenham*.

1824 George Edwards.

1823 C. C. Egerton, *India*.

1814 Philip Elliot, M.D., *Bath*.

1838 Thomas Elliotson, M.D., *Clapham*.

1835 William England, M.D., *Wisbeach*.

1842 John E. Erichsen, *Lecturer on General Anatomy and Physiology at the Westminster Hospital*; 48, *Welbeck-street, Cavendish-square*.

1815 G. F. D. Evans, M.D., *Hill-street, Berkeley-square*. C. 1838.

1836 George F. Evans, M.B., *Physician to the Birmingham Hospital*.

1845 William Julian Evans, M.D., 25, *Henrietta-street, Cavendish-square*.

1841 Sir James Eyre, M.D., *Physician-Accoucheur to St. George's and St. James's Dispensary*; 11, *Brook-street, Grosvenor-square*.

ELECTED

1844 Arthur Farre, M.D., F.R.S., *Professor of Midwifery in King's College, London; Curzon-street, May-fair.*

1831 Robert Ferguson, M.D., *Physician-Accoucheur to the Queen, Physician to the Westminster Lying-in Hospital; Queen-street, May-fair.* C. 1839.

1841 William Fergusson, F.R.S. Ed., *Professor of Surgery in King's College, London; and Surgeon to King's College Hospital;* 8, *Dover-street, Piccadilly.*

1841 William Finch, M.D., F.L.S., *Laverstock-hall, Salisbury.*

1836 John W. Fisher, *Surgeon-in-Chief to the Metropolitan Police Force;* 7, *Upper Grosvenor-street.* C. 1843.

1839 George Lionel Fitzmaurice, 97, *Gloucester-place, Portman-square.*

1840 Valentine Flood, M.D., 45, *Victoria-terrace, Portland-town.*

1842 Thomas Bell Elcock Fletcher, M.D., *Physician to the General Dispensary, Birmingham.*

1841 John Forbes, M.D., F.R.S., *Physician to Her Majesty's Household; Old Burlington-street.*

1817 *Robert T. Forster, *Southwell.*

1820 Thomas Forster, M.D., *Hartfield-lodge, East Grinsted.*

1846 Algernon Frampton, M.D., *Physician to the London Hospital; New Broad-street.*

1816 John W. Francis, M.D., *Professor of Materia Medica in the University of New York.*

1841 J. Ch. August. Franz, M.D., *Royal German Spa, Brighton.*

1843 Patrick Fraser, M.D., *Assistant-Physician to the London Hospital; Guilford-street, Russell-square.*

1846 Joseph Freeman, *Spring-gardens.*

1836 John G. French, *Surgeon to St. James's Infirmary;* 41, *Great Marlborough-street.*

1846 Henry William Fuller, M.B., 45, *Half Moon-street, Piccadilly.*

1815 *George Frederick Furnival, *Egham.*

1819 John Samuel Gaskoin, 32, *Clarges-street.* C. 1836.

1819 Henry Gaulter.

1821 *Richard Francis George, *Surgeon to the Bath Hospital.*

ELECTED

1841 J. Durancè George, F.G.S., *Lecturer on Dental Surgery to University College, and Dental Surgeon to University College Hospital;* 32, *Old Burlington-street.*

1812 George Goldie, M.D., *York.*

1837 Richard H. Goolden, M.D., *Physician to the Hospital-ship Dreadnought, Assistant-Physician to St. Thomas's Hospital; John-street, Adelphi.*

1818 James Alexander Gordon, M.D., F.R.S. C. 1828. V. P. 1829.

1844 John Grantham, *Crayford, Kent.*

1846 George Thompson Gream, *Surgeon to Queen Charlotte's Lying-in Hospital;* 42, *Hertford-street, May-fair.*

1816 Joseph Henry Green, F.R.S., *Surgeon to St. Thomas's Hospital; Hadley, Middlesex.* C. 1820. V. P. 1830.

1841 George Gregory, M.D., *Physician to the Small-Pox Hospital;* 31, *Weymouth-street.* S. 1825.

1843 Robert Greenhalgh, *Upper Charlotte-street, Fitzroy-square.*

1835 William Griffith, *Surgeon to the Royal Maternity Charity; Lower Belgrave-street, Belgrave-square.*

1814 John Grove, M.D., *Salisbury.*

1837 James Manby Gully, M.D., *Holyrood-house, Great Malvern.*

1819 John Gunning, *Inspector of Hospitals; Paris.*

1841 Charles Guthrie, *Assistant-Surgeon to the Westminster Ophthalmic Hospital; Saville-row.*

1827 Marshall Hall, M.D., F.R.S., *Manchester-square.* L. 1828. C. 1840. V. P. 1843.

1842 *George Hall, M.D., 14, *Old Steine, Brighton.*

1845 John Hall, M.D., *Staff Surgeon, Junior United Service Club.*

1819 Thomas Hammerton, 111, *Piccadilly.* C. 1829.

1838 Henry Hancock, *Surgeon to the Charing Cross Hospital; Harley-street.*

1836 J. F. Harding, 6, *Mylne-street, Myddelton-square.*

1843 Thomas Sunderland Harrison, M.D., F.L.S., *Garston-lodge, Somersetshire.*

1846 John Harrison, *The Court-yard, Albany.*

ELECTED

1841 William Harvey, *Surgeon to the Freemasons' Female Charity;* 43, *Great Queen-street, Lincoln's-inn-fields.*

1845 John Havers, *Bedford-place, Russell-square.*

1816 *John Haviland, M.D., *Regius Professor of Physic in the University of Cambridge; Physician to Addenbrooke's Hospital; Cambridge.*

1828 Cæsar Hawkins, *Surgeon to, and Lecturer on Surgery at, St. George's Hospital;* 26, *Lower Grosvenor-street.* C. 1830. V. P. 1838. T. 1841.

1838 Charles Hawkins, *The Court-yard, Albany.* C. 1846.

1820 Thomas Emerson Headlam, M.D., *Newcastle-upon-Tyne.*

1829 Thomas Heberden, M.D., 11, *Upper Brook-street.*

1844 John Hennen, M.D., *Physician to the Western General Dispensary;* 24, *Upper Southwick-street, Hyde-park.*

1821 Vincent Herberski, M.D., *Professor of Medicine in the University of Wilna.*

1843 Prescott Gardner Hewett, *Lecturer on Anatomy at St. George's Hospital Medical School; Vigo-street, Burlington-gardens.*

1841 *Nathaniel Highmore, *Consulting-Surgeon to the Weymouth and Dorsetshire Eye Infirmary; Sherborne.*

1814 *William Hill, *Wootton-under-Edge.*

1842 William Augustus Hillman, *Surgeon to the Farringdon-street Dispensary; Argyll-street.*

1841 John Hilton, F.R.S., *Assistant-Surgeon to, and Lecturer on Anatomy at, Guy's Hospital;* 10, *New Broad-street.*

1840 Thomas Hodgkin, M.D., 9, *Brook-street.* C 1842.

1813 Joseph Hodgson, F.R.S., *Surgeon to the General Hospital, and to the Eye Infirmary, Birmingham.* C. 1817.

1835 T. H. Holberton, *Surgeon Extraordinary to the Queen Dowager; Hampton.*

1843 Luther Holden, *Old Jewry.*

1814 Henry Holland, M.D., F.R.S., *Physician Extraordinary to the Queen, and Physician in Ordinary to His Royal Highness Prince Albert;* 25, *Brook-street.* C. 1817. V. P. 1826.

ELECTED

1846 Bernard William Holt, *Abingdon street, Westminster.*

1846 Carsten Holthouse, *Surgeon to the Public Dispensary, Lincoln's Inn; Lecturer on Anatomy and Physiology;* 3, *Serle-street, Lincoln's-inn-fields.*

1819 *John Howell, M.D., F.R.S. Ed., *Clifton.*

1828 *Edward Howell, M.D., *Swansea.*

1844 Edwin Humby, *Windsor-terrace, Maida-hill.*

1822 Robert Hume, M.D., *Inspector of Hospitals; Commissioner in Lunacy;* 9, *Curzon-street.* V. P. 1836.

1840 Henry Hunt, M.D., *Brook-street, Hanover-square.*

1842 Christopher Hunter, *Downham, Norfolk.*

1820 William Hutchinson, M.D.

1840 Charles Hutton, M.D., 25, *Motcomb-street, Belgrave-square.*

1838 William Ifil, M.D.

1826 William Ingram, *Midhurst.*

1839 A. R. Jackson, M.D., *East India Company's Depôt, Warley Barracks, Essex.*

1845 *Henry Jackson, *Surgeon to the Sheffield General Infirmary; St. James's row, Sheffield.*

1841 Paul Jackson, *Thayer-street, Manchester-square.*

1841 Maximilian M. Jacobovicz, M.D., *Pesth.*

1825 John B. James, M.D.

1844 Samuel John Jeaffreson, M.D., *Warwick.*

1839 Julius Jeffreys, F.R.S., 25 A, *Norfolk-crescent, Hyde-park.*

1840 *G. Samuel Jenks, M.D., *Brighton.*

1821 Edward Johnson, M.D., *Weymouth.*

1837 Henry Charles Johnson, *Assistant-Surgeon to, and Lecturer on Medical Jurisprudence at, St. George's Hospital; Saville-row.*

1844 John Johnston, 16, *Dover-street, Piccadilly.*

1844 Henry Bence Jones, M.A., F.R.S., *Physician to, and Lecturer on Medical Jurisprudence at, St. George's Hospital; Lower Grosvenor-street.*

1835 H. D. Jones, 20, *Soho-square.*

ELECTED

1818 W. Mackenzie, *Surgeon to the Eye Infirmary, Glasgow.*

1822 Richard Macintosh, M.D.

1844 James Sutherland Mackintosh, *Wilton-place, Knightsbridge.*

1846 William M'Ewen, M.D., *Surgeon to the Cheshire County Gaol, and House Surgeon to the Chester General Infirmary; Newgate-street, Chester.*

1839 William Macintyre, M.D., *Harley-street.*

1844 Daniel Maclachlan, M.D., *Physician to the Royal Hospital, Chelsea.*

1842 John Macnaught, M.D., *Bedford-street, Liverpool.*

1835 D. C. Macreight, M.D., *St. Hillier's, Jersey.*

1837 A. M. M'Whinnie, *Demonstrator of Anatomy, and Lecturer on Comparative Anatomy, at St. Bartholomew's Hospital; Bridge-street, Blackfriars.*

1836 John Malyn, *Surgeon to the Western Dispensary, and to the Infirmary of St. Margaret and St. John;* 12, *James-street, Buckingham-gate.*

1824 Sir Henry Marsh, Bart., M.D., *Dublin.*

1838 Thomas Parr Marsh, M.D., *Physician to the Salop Infirmary, Shrewsbury.*

1840 John Marston, 6, *Devonshire-street, Portland-place.*

1841 James Ranald Martin, F.R.S., 71 A, *Grosvenor-street.*

1819 *John Masfen, *Surgeon to the County General Infirmary, and Fever Hospital, Stafford.*

1818 J. P. Maunoir, *Professor of Surgery at Geneva.*

1820 Herbert Mayo, F.R.S. S. 1825. V. P. 1834.

1837 Thomas Mayo, M.D., F.R.S, *Physician to the St. Marylebone Infirmary; Wimpole-street.* S. 1841.

1839 R. H. Meade, *Bradford, Yorkshire.*

1819 *Thomas Medhurst, *Hurstbourne Tarrant.*

1811 Samuel Merriman, M.D., F.L.S., 34, *Brook-street.* C. 1813. V. P. 1827. T. 1837.

1837 S. W. J. Merriman, M.D., *Physician to the Westminster General Dispensary; Brook-street.*

1815 Augustus Meyer, M.D., *St. Petersburgh.*

ELECTED

1840 Richard Middlemore, *Surgeon to the Eye Infirmary, Birmingham.*

1818 *Patrick Miller, M.D., F.R.S. Ed., *Physician to the Devon and Exeter Hospitals, and to the Lunatic Asylum; Exeter.*

1844 Nathaniel Montefiore.

1828 Joseph Moore, M.D., *Physician to the Royal Freemasons' Female Charity;* 10, *Saville-row.* C. 1837.

1836 George Moore, M.D., *Hastings.*

1842 Thomas Morton, *Assistant-Surgeon to University College Hospital, and Surgeon to the Queen's Prison;* 7, *Woburn-place, Russell-square.*

1814 *George Frederick Muhry, M.D., *Hanover.*

1841 Edward William Murphy, M.D., *Professor of Midwifery in University College; Henrietta-street, Cavendish-square.*

1845 Thomas D. Mutter, M.D., *Professor of Surgery in Jefferson Medical College, Philadelphia.*

1840 Robert Nairne, M.D., *Physician to, and Lecturer on Medicine at, St. George's Hospital;* 44, *Charles-street, Berkeley-square.*

1831 Alexander Nasmyth, *Surgeon-Dentist to His Royal Highness Prince Albert;* 13, *George-street, Hanover-square.* C. 1844.

1805 Thomas Nelson, M.D., *Tonbridge Wells.* C. 1810. V.P. 1836.

1835 Thomas Andrew Nelson, M.D., 41, *George-street, Portman-square.*

1843 Edward Newton, *Howland-street, Fitzroy-square.*

1816 Thomas Nixon, *(Army.)*

1819 *George Norman, *Surgeon to the United Hospital and Puerperal Charity; Bath.*

1845 Henry Norris, *South Petherton, Somerset.*

1829 John North, *Gloucester-place.* C. 1835.

1843 William O'Connor, 21, *George-street, Portman-square.*

1822 James Adey Ogle, M.D., F.R.S., *Clinical and Aldrichian Professor of Medicine, Oxford; and Senior Physician to the Radcliffe Infirmary.*

ELECTED

1844 Edward Lodge Ogle, 25, *South-street, Grosvenor-square.*

1842 William Piers Ormerod, *Oxford.*

1846 Edward Latham Ormerod, M.B., *Demonstrator of Morbid Anatomy at St. Bartholomew's Hospital;* 10, *Somerset-street, Portman-square.*

1844 Drewry Ottley, *Bedford-place, Russell-square.*

1840 James Paget, *Lecturer on General and Morbid Anatomy and Physiology, and Warden of the Collegiate Establishment at St. Bartholomew's Hospital.*

1806 *Robert Paley, M.D., *Bishopston-grange, near Ripon, Yorkshire.*

1814 John Ranicar Park, M.D.

1836 J. W. Langston Parker, *Birmingham.*

1843 *Charles Lewis Parker, A.M., *Surgeon to the Radcliffe Infirmary, Oxford.*

1841 John Parkin, *York-place, Battersea.*

1828 Richard Partridge, F.R.S., *Surgeon to King's College Hospital, and Professor of Anatomy in King's College, London;* 17, *New-street, Spring-gardens.* S. 1832. C. 1837.

1819 Granville Sharp Pattison, *New York.*

1845 Thomas Bevill Peacock, M.D., *Physician to the Royal General Dispensary; Finsbury-pavement.*

1830 Charles P. Pelechin, M.D., *St. Petersburg.*

1830 William Pennington, 21, *Montague-place, Russell-square.*

1819 John Pryor Peregrine, 3, *Half-moon-street.*

1839 Thomas Peregrine, 3, *Half-moon-street.*

1831 Jonathan Pereira, M.D., F.R.S., F.L.S., *Assistant-Physician to, and Lecturer on Materia Medica at, the London Hospital; Finsbury-square.* C. 1844.

1836 John George Perry, F.G.S., VICE-PRESIDENT, *Inspector of Prisons;* 12, *Westbourne-street, Hyde Park-gardens.* C. 1831. S. 1837. V. P. 1845.

1844 William V. Pettigrew, 30, *Chester-street, Grosvenor-place.*

1814 *Edward Phillips, M.D., *Physician to the County Hospital; Winchester.*

ELECTED

1837 Benjamin Phillips, F.R.S., *Assistant-Surgeon to, and Lecturer on Surgery at, the Westminster Hospital;* 17, *Wimpole-street.* L. 1841.

1846 Francis Richard Philp, M.D., *Physician to St. Luke's Hospital;* 28, *Grosvenor-street.*

1836 Isaac Pidduck, M.D., 22, *Montague-street, Russell-square.*

1841 Henry Pitman, M.D., *Assistant-Physician to, and Lecturer on Materia Medica at, St. George's Hospital; Montague-place, Russell-square.*

1845 George David Pollock, *Curator of St. George's Hospital Museum; Bruton-street, Berkeley-square.*

1843 Charles Pope, M.D., M.A., F.L.S., *Temple Cloud, near Bristol.*

1844 John Philips Potter, *Demonstrator of Anatomy at University College Hospital;* 308, *Regent street, Langham-place.*

1846 Jephson Potter, M.D., F.L.S., 13, *Oxford-road, Manchester.*

1840 Lewis Powell, *John-street, Berkeley-square.*

1842 James Powell, M.B., *Great Coram-street, Brunswick-square.*

1839 John Propert, *New Cavendish-street.*

1814 William Prout, M.D., F.R.S., *Sackville-street.* C. 1816. V. P. 1823.

1845 John Pyle, *Oxford-terrace, Hyde-park.*

1816 Sir William Pym, M.D., *Inspector of Hospitals.*

1830 Jones Quain, M.D., *Paris.*

1835 Richard Quain, F.R.S., LIBRARIAN, *Surgeon to University College Hospital, and Professor of Anatomy in University College; Keppel-street.* C. 1838. L. 1846.

1807 John Ramsey, M.D., *Physician to the Infirmary at Newcastle.*

1821 Henry Reeder, M.D., *Ridge-house, Chipping, Sudbury.*

1835 G. Regnoli, *Professor of Surgery in the University of Pisa.*

1842 David Boswell Reid, M.D., *House of Commons.*

1846 James Reid, M.D., *Physician to the Infirmary of St. Giles and Bloomsbury; General Lying-in Hospital, &c.; Bloomsbury-square.*

1829 John Richardson, M.D., F.R.S., *Surgeon to the Naval Hospital, Chatham.*

ELECTED

1843 Joseph Ridge, M.D., *Cavendish-square.*

1845 Benjamin Ridge, M.D., *Putney, Surrey.*

1817 *John Robb, M.D., *Deputy Inspector of Hospitals.*

1821 Charles Julius Roberts, M.D., *Physician to the Adult Deaf and Dumb and Welsh Charity;* 31, *New Bridge-street.* C. 1827.

1829 *Archibald Robertson, M.D., F.R.S. L. and Ed., *Physician to the General Infirmary, Northampton.*

1843 George Robinson, M.D., 40, *Blackett-street, Newcastle-on-Tyne.*

1845 J. M. Edward Roche, M.D., 12, *Cumberland-street, Portman-square.*

1843 William Roden, M.D., A.M., F.L.S., *Kidderminster.*

1835 George Hamilton Roe, M.D., *Physician to, and Lecturer on Medicine at, the Westminster Hospital;* 6, *Hanover-square.* C. 1841.

1836 Arnold Rogers, 296, *Regent-street.*

1846 William Rogers, M.D., *Mortimer-street, Cavendish-square.*

1819 Henry S. Roots, M.D., 2, *Russell-square.* C. 1833. V. P. 1834.

1829 Sudlow Roots, *Kingston-on-Thames.*

1836 Richard Roscoe, M.D.

1835 *Caleb B. Rose, *Swaffham.*

1845 Henry Mortimer Rowden, *Lecturer on Anatomy at the Middlesex Hospital School of Medicine*; *Bayham-terrace, Camden-town.*

1841 Richard Rowland, M.D., *Physician to the Bloomsbury Dispensary;* 7, *Woburn-place, Russell-square.*

1837 J. Forbes Royle, M.D., F.R.S., F.L.S., F.Z.S., *Professor of Materia Medica and Therapeutics in King's College, London;* 4, *Bulstrode-street, Manchester-square.* C. 1846.

1836 James Russell, *Birmingham.*

1845 James Russell, Jun., *Birmingham.*

1827 *Thomas Salter, F.L.S., *Poole.*

1844 *Thomas Bell Salter, M.D., F.L.S., *Ryde, Isle of Wight.*

1842 George Sampson, 12, *Chester-street, Belgrave-square.*

ELECTED

1845 Edwin Saunders, *Surgeon-Dentist and Lecturer on Diseases of the Teeth at St. Thomas's Hospital*; *Argyll-street.*

1831 Ludwig V. Sauvan, M.D., *Warsaw.*

1840 Augustin Sayer, M.D., 28, *Upper Seymour-street.*

1821 Page Nichol Scott, *Norwich.*

1824 Edward J. Seymour, M.D., F.R.S., *Charles-street, Berkeley-square.* C. 1826. S. 1827. V. P. 1830.

1840 William Sharp, F.R.S., F.G.S., F.R.A.S., *late Senior Surgeon to the Bradford Infirmary; Humber Bank House, Hull.*

1837 William Sharpey, M.D., F.R.S. L. and Ed., *Professor of Anatomy and Physiology in University College, London; Gloucester-crescent, Regent's-park.*

1836 Alexander Shaw, *Surgeon to the Middlesex Hospital; Henrietta-street, Cavendish-square.* C. 1842. S. 1843.

1839 Thomas Silvester, M.D., *High-street, Clapham.*

1842 John Simon, F.R.S., *Assistant-Surgeon to King's College Hospital, and Demonstrator of Anatomy in King's College*; 11, *Wellington-street, Strand.*

1821 Charles Skene, M.D., *Professor of Anatomy and Surgery; Marischal College, Aberdeen.*

1827 George Skene, *Bedford.*

1812 Joseph Skey, M.D., *Inspector-General of Hospitals.*

1824 Frederick C. Skey, F.R.S., *Assistant-Surgeon to, and Lecturer on Anatomy at, St. Bartholomew's Hospital; Surgeon to the Northern Dispensary; Grosvenor-street.* C. 1828. L. 1829. V. P. 1841.

1810 Noel Thomas Smith, M.D., *Newcastle.*

1822 Southwood Smith, M.D., *Physician to the Fever Hospital, and to the Eastern Dispensary;* 38, *Finsbury-square.* C. 1838.

1835 John Gregory Smith, *Harewood, Yorkshire.*

1838 Henry Smith, *Surgeon to the General Dispensary, Aldersgate-street;* 17, *Henrietta-street, Cavendish-square.*

1845 William Smith, *Upper Berkeley-place, Bristol.*

ELECTED

1843 Robert William Smith, A.M., M.D., M.R.I.A., *Lecturer on Surgery at the Richmond Hospital School of Medicine; Surgeon to the Talbot General Dispensary and Island Bridge Lunatic Asylum;* 62, *Eccles-street, Dublin.*

1843 John Snow, M.D., *Frith-street, Soho-square.*

1819 *George Snowden, *Ramsgate.*

1816 *John Smith Soden, *Surgeon to the United Hospital, to the Eye Infirmary, and to the Penitentiary and Lock Hospital; Clifton.*

1830 Samuel Solly, F.R.S., *Assistant-Surgeon to St. Thomas's Hospital; Surgeon to the General Dispensary, Aldersgate-street;* 1, *St. Helen's-place.* L. 1838. C. 1845.

1844 Frederick R. Spackman, M.B., *Harpenden, St. Alban's.*

1834 James Spark, *Newcastle.*

1843 *Stephen Spranger, *Swatheling-house, Southampton.*

1838 George Squibb, 6, *Orchard-street.*

1835 Richard A. Stafford, *Surgeon Extraordinary to His Royal Highness the Duke of Cambridge; Surgeon to the St. Marylebone Infirmary; Old Burlington-street.* C. 1840.

1815 Edward Stanley, F.R.S., *Surgeon to St. Bartholomew's Hospital;* 23 A, *Brook-street.* C. 1821. S. 1824. V.P. 1827. T. 1832. P. 1843.

1835 Leonard Stewart, M.D., *Keppel-street.*

1842 Alexander Patrick Stewart, M.D., *Physician to the St. Pancras Dispensary;* 130, *Mount-street, Berkeley-square.*

1839 Thomas Stone, M.D.

1843 Robert Reeve Storks, *Surgeon to the Blenheim-street Dispensary; Gower-street, Bedford-square.*

1844 John Soper Streeter, *Harpur-street, Red Lion-square.*

1827 William Stroud, M.D., 20, *Great Coram-street.* C. 1831.

1839 Alexander John Sutherland, M.D., *Physician to St. Luke's Hospital; Parliament-street.*

1842 James Syme, *Professor of Clinical Surgery in the University of Edinburgh; Charlotte-square, Edinburgh.*

1844 R. W. Tamplin, *Surgeon to the Orthopædic Institution, Great Queen-street, Lincoln's-inn-fields.*

ELECTED

1840 Thomas Tatum, *Surgeon to, and Lecturer on Surgery at, St. George's Hospital; George-street, Hanover-square.*

1835 J. C. Taunton, *Surgeon to the City of London Truss Society, and to the City Dispensary;* 48, *Hatton-garden.* C. 1840.

1845 John Taylor, M.D., *Physician to the Infirmary, Huddersfield.*

1845 Thomas Taylor, *New Bridge-street, Blackfriars.*

1817 Frederick Thackeray, M.D., *Physician to Addenbrooke's Hospital, Cambridge.*

1845 Evan Thomas, *Pwllheli, North Wales.*

1839 Seth Thompson, M.D., *Assistant-Physician to, and Lecturer on Pathology at, the Middlesex Hospital;* 1, *Lower Seymour-street.*

1842 Theophilus Thompson, M.D., F.R.S., *Physician to the Northern Dispensary, and to the Hospital for Consumption and Diseases of the Chest;* 3, *Bedford-square.*

1835 Frederick Hale Thomson, *Surgeon to the Westminster Hospital; Berners-street.*

1815 *John Thomson, M.D., F.R.S. Ed., *Surgeon to the Forces; Edinburgh.*

1819 John Thomson, M.D., F.L.S., *Physician to the Finsbury Dispensary;* 80, *Coleman-street.* C. 1833. L. 1834.

1836 John Thurnam, M.D., *The Retreat, York.*

1834 Robert Bentley Todd, M.D., F.R.S., Librarian, *Physician to King's College Hospital, Professor of Physiology and of General and Morbid Anatomy in King's College; New-street, Spring-gardens.* L. 1842.

1828 James Torrie, M.D., *Aberdeen.*

1843 Joseph Toynbee, F.R.S., *Surgeon to the St. George's and St. James's Dispensary; Argyll-place, Regent-street.*

1808 Benjamin Travers, F.R.S., *Surgeon Extraordinary to the Queen; Surgeon in Ordinary to His Royal Highness Prince Albert;* 12, *Bruton-street.* C. 1810. V.P. 1817. P. 1827.

1821 *William Travers, M.D., *Scarborough.*

1841 Matthew Truman, M.D., 44, *Gloucester-place, Kentish-town.*

ELECTED

1835 John Cusson Turner, M.D., *Hanwell-park, Middlesex.*

1845 Thomas Turner, *Surgeon to the Royal Manchester Infirmary, and Lecturer on Anatomy; Mosley-street, Manchester.*

1843 William Twining, M.D., *Physician to the North London Ophthalmic Institution; Bedford-place, Russell-square.*

1819 Barnard Van Oven, *Consulting Surgeon to the Charity for Delivering Jewish Lying-in Women;* 30, *Gower-street, Bedford-square.*

1845 R. A. Varicas.

1806 Bowyer Vaux, *Surgeon to the General Hospital, Birmingham.*

1839 W. R. Vickers, 32, *Baker-street.*

1814 John P. Vincent, *Surgeon to St. Bartholomew's Hospital;* 16, *Lincoln's-inn-fields.* C. 1823. V. P. 1837.

1810 James Vose, M.D.

1846 Alexander Ure, *Surgeon to the Westminster General Dispensary;* 13, *Charlotte-street, Bedford-square.*

1828 Benedetto Vulpes, M.D., *Physician to the Hospital of Aversa, and to the Hospital of Incurables, Naples.*

1841 Robert Wade, *Surgeon to the Westminster General Dispensary;* 68, *Dean-street.*

1823 William Wagner, M.D., *Berlin.*

1820 Thomas Walker, M.D., *Physician to the Forces, and to the Embassy at St. Petersburgh.*

1821 Tilleard Ward.

1845 T. Ogier Ward, M.D., *Leonard-place, Kensington.*

1846 Nathaniel Ward, *Demonstrator of Anatomy at the London Hospital;* 17, *Finsbury-place, South.*

1814 Martin Ware, 51, *Russell-square.* C. 1844. T. 1846.

1811 John Ware.

1846 James Thomas Ware, *Surgeon to the Finsbury Dispensary;* 51, *Russell-square.*

1816 *Charles Bruce Warner, *Cirencester.*

1829 E. T. Warry, *Lyndhurst.*

1837 Thomas Watson, M.D., VICE-PRESIDENT, *Henrietta-street, Cavendish-square.* C. 1840. V. P. 1845.

1818 *Charles Webb, *Oxford.*

ELECTED

1842 Frederick Weber, M.D., *Physician to the St. George's and St. James's Dispensary; Lower Grosvenor-street.*

1844 William Wegg, M.D., 5, *Maddox-street, Hanover-square.*

1842 Charles West, M.D., *Lecturer on Midwifery at the Middlesex Hospital, and Senior Physician to the Royal Infirmary for Children; 96, Wimpole-street, Cavendish-square.*

1841 Thomas West, M.D., F.L.S., *Hertford-street, Coventry.*

1840 William Woodham Webb, *Gislingham, near Thwaite, Suffolk.*

1835 John Webster, M.D., F.R.S., *Consulting Physician to the St. George's and St. James's Dispensary; 24, Brook-street.* C. 1843.

1821 Richard Welbank, *Chancery-lane.* C. 1826. V. P. 1845.

1816 Sir Augustus West, *Deputy Inspector of Hospitals to the Portuguese Forces; Lisbon.*

1828 John Whatley, M.D.

1840 Joseph Wickenden, *Birmingham.*

1824 *William Wickham, *Surgeon to the Winchester Hospital.*

1811 Arthur Ladbroke Wigan.

1844 Frederick Wildbore, *High-street, Shoreditch.*

1837 G. A. F. Wilks, M.D., 19, *Hart-street, Bloomsbury-square.*

1840 C. J. B. Williams, M.D., F.R.S., *Professor of Medicine in University College, and Physician to University College Hospital; Holles-street.*

1829 Robert Willis, M.D., *Barnes.* L. 1838.

1831 *W. J. Wilson, *Surgeon to the Manchester Infirmary.*

1839 Erasmus Wilson, F.R.S., *Lecturer on Anatomy and Physiology in the Middlesex Hospital, and Consulting Surgeon to the St. Pancras Infirmary; Charlotte-street, Fitzroy-square.*

1839 James Arthur Wilson, M.D., *Physician to St. George's Hospital; Dover-street.* C. 1846.

1825 Thomas A. Wise, *India.*

1841 George Leighton Wood, *Surgeon to the Bath Hospital; Queen-square, Bath.*

1843 John Ward Woodfall, M.D., *Physician to the Western Dispensary;* 33. *Davies-street, Berkeley-square.*

ELECTED

1833 Thomas Wormald, *Assistant-Surgeon to St. Bartholomew's Hospital; Bedford-row.* C. 1839.

1842 W. C. Worthington, *Surgeon to the Infirmary, Lowestoft, Suffolk.*

1835 John Wright, M.D., *Prince's-court, Westminster.*

[It is particularly requested that any change of Title or Residence may be communicated to the Secretaries before the 1st August in each year, in order that the List may be made as correct as possible.]

HONORARY FELLOWS.

ELECTED

1841 William Thomas Brande, F.R.S. L. and Ed., *Professor of Chimistry at the Royal Institution of Great Britain; Royal Mint, Tower-hill.*

Sir David Brewster, K.H., LL.D., F.R.S. L and Ed., &c., *Cor. Mem. Roy. Institute of France, &c.; Kingussie.*

1841 Robert Brown, D.C.L., F.R.S., *Vice-President of the Linnean Society; British Museum.*

The Very Rev. William Buckland, D.D., F.R.S., *Dean of Westminster.*

1835 William Clift, F.R.S., *Royal College of Surgeons.*

1835 Michael Faraday, D.C.L., F.R.S., *Royal Institution.*

1809 Charles Hatchett, F.R.S., *Hammersmith.*

1841 Sir John Frederick William Herschel, Bart., D.C.L., F.R.S., *President of the Royal Astronomical Society; Somerset House.*

1841 Sir William J. Hooker, LL.D., F.R.S. L. and Ed., *Royal Botanic Garden, Kew.*

1841 The Rev. A. Sedgwick, A.M., F.R.S., &c., *Woodwardian Lecturer, Cambridge.*

1841 The Rev. William Whewell, B.D., F.R.S., *Master of Trinity College, Cambridge.*

FOREIGN HONORARY FELLOWS.

ELECTED

1841 G. Andral, M.D., *Professor in the Faculty of Medicine; Consulting Physician to the King; Paris.*

1815 Paolo Asalini, M.D., *Professor of Surgery, and Chief Surgeon to the Military Hospital at Milan, &c.*

1813 Jacob Berzelius, M.D., F.R.S., *Professor of Chimistry in the University of Stockholm.*

Carl Johan Eckström, K.P.S. and W., *Physician to the King of Sweden, First Surgeon to the Seraphim Hospital, Stockholm.*

W. J. Edwards, M.D., F.R.S., *Member of the Institute of France; Paris.*

1841 Christian Gottfried Ehrenberg, *Berlin.*

Baron A. de Humboldt, *Member of the Institute of France, &c.; Berlin.*

1841 James Jackson, M.D., *Professor of Medicine in the Haward University, Boston, Massachusetts.*

1843 Baron Justus Liebig, M.D., F.R.S., *Professor of Chimistry in the University of Giessen, &c.*

1841 P. C. A. Louis, M.D., *Principal Clinical Professor of the Faculty of Medicine; Paris.*

1841 F. Magendie, M.D., *Member of the Institute; Physician to the Hospital of the Salpetrière; Paris.*

1841 Johann Müller, M.D., *Professor of Anatomy and Physiology; Director of the Royal Anatomical Museum; Berlin.*

J. C. Oersted, M.D., *Professor of Physics in the University of Copenhagen, &c., &c.*

Professor Orfila, *Dean of Faculty, and Physician to the King of the French, &c., &c.; Paris.*

1841 Bartolomeo Panizza, M.D., *Pavia.*

1843 Philibert Joseph Roux, *Member of the French Institute; Surgeon in Chief of the Hôtel Dieu; Professor in the Faculty of Medicine; Paris.*

C. J. Temminck, *Director of the Museum of Natural History of the King of Holland; Amsterdam.*

Friederich Tiedemann, M.D., *Professor of Anatomy and Physiology; Heidelberg.*

Giacomo Tommasini, M.D., *Parma.*

1841 John C. Warren, M.D., *Professor of Surgery in the Haward University, Boston, Massachusetts.*

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ON THE

MINUTE ANATOMY AND PATHOLOGY

OF

BRIGHT'S DISEASE OF THE KIDNEY,

AND ON THE

RELATION OF THE RENAL DISEASE TO THOSE DISEASES OF THE LIVER, HEART, AND ARTERIES, WITH WHICH IT IS COMMONLY ASSOCIATED.

By GEORGE JOHNSON, M.D.

Communicated by R. B. TODD, M.D., F.R.S.

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There is, perhaps, no single disease which has excited more interest among all classes of the profession, than that form of renal degeneration, the existence of which was first made known by Dr. Bright, and which has been named after that distinguished physician.

In all that relates to the clinical study of Bright's disease, the labours of Dr. Bright, and of his followers, have been attended by an amount of success almost unprecedented in the history of any other disease. Pathologists, however, have not as yet succeeded in obtaining a knowledge of the precise nature of those changes which the kidney undergoes in the course of this disease. This want of success may, perhaps, be attributed to the fact, that those who have entered upon the investigation, have done so with a certain preconceived notion on the subject, which has induced them

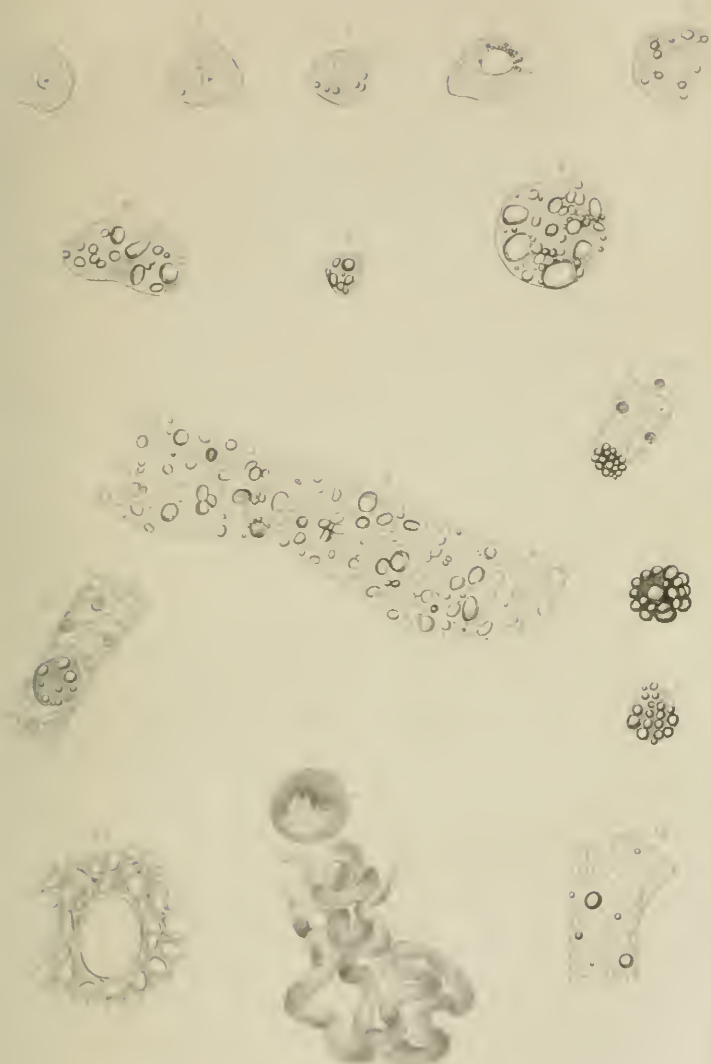
to direct their attention too exclusively to the vascular system of the gland, while they have neglected the study of other portions of the organ, which, there seems reason to believe, are primarily and essentially concerned in the disease; the parts to which I refer are the urinary tubules, with their lining of secreting, or epithelial, cells.

I have ascertained that the epithelial cells of the healthy kidney contain a minute quantity of oil, in the form of yellowish, highly refracting globules, the appearance of which in the cells of the liver is well known to microscopical observers. The quantity of fat in the cells of the healthy kidney is much less than in those of the healthy liver, but I have found it present, in greater or less quantities, in the healthy kidneys of more than twenty subjects which I have examined for this point, since my attention was first directed to it.

In every healthy kidney there are many cells entirely free from oil (see Plate I. fig. 1), while others contain only one or two minute particles (figs. 2 and 3); others, again, contain several scattered over the interior of the cell (fig. 4). The quantity in different kidneys varies greatly within the limits of health, and I have generally observed that when the liver cells contain a more than ordinary amount of fat, the kidney cells in the same subject present an unusual quantity of the same material. In two or three cases, the quantity of fat in the kidneys has been extremely small, but never entirely absent.

The secreting cells of the kidney, then, resemble those of the liver, in containing a certain proportion of oil, and the presence of this material in such a situation appears to indicate that a certain quantity of fat is excreted by the kidneys, as well as by the liver.

Having premised thus much of the healthy epithelium, with its contents, Bright's disease may be described as *primarily and essentially an exaggeration of the fatty matter which exists naturally in small quantities in the epithelial cells of the healthy organ.* A specimen of the disease in an



advanced stage, examined with the microscope, presents epithelial cells in every degree of engorgement, from the incipient enlargement of the particles in fig. 5, in which the cell nucleus is still visible, to the complete engorgement of the cell in figs. 6, 7, and 8, in which the nucleus is concealed by the fatty globules.

The disease, then, appears to be a fatty degeneration of the kidney, precisely analogous to the fatty degeneration of the liver.

It will scarcely be necessary to remind the Society, that about four years since, Mr. Bowman* discovered that in fatty degeneration of the liver, the fat is contained in the secreting cells of the organ; that it is, in fact, an increase of those fatty globules, the existence of which, in small quantities, in the cells of the healthy gland, had been previously discovered by Henle and Mr. Erasmus Wilson.

Returning to the kidney. If a portion of the diseased gland be torn up with needles, and examined with a magnifying power of about 400 diameters, the gorged tubes are seen presenting the appearance represented in fig. 9. In examining a section of the cortical portion of the kidney with a power of 100 diameters, sets of convoluted tubes are seen crowded with their fatty contents. A set of gorged tubes, presenting itself either on the surface of the gland, or on the surface of a section, would constitute one of the so-called "granulations of Bright." So that, by examining a section by a low power, it is ascertained that the deposit is contained within the tubes; and by breaking up the tubes and examining them with a higher power, we arrive at a knowledge of the fact, that the fatty material is contained within the epithelial cells which line the tubes.

The presence of oil globules in a free state, or in any other situation than in the tubes, is accounted for by the rupture of the cells and tubes, which probably is a frequent occurrence, in consequence of their over-distension by the accumulated fat.

* Lancet, January 1842.

The accumulation does not take place simultaneously and equally in every part of the tubes. Those portions of the tubes which form the pyramids, and which are lined by epithelium, having more the character of the epithelium lining excretory ducts, than that of the true glandular epithelium, these portions of the tubes, with their lining epithelium, do not become gorged in any great degree, except in cases where the disease has been of long duration, and in which the cortical portion of the kidney has become wasted. In these cases, the epithelium of the cones becomes gorged with fat; perhaps, in consequence of its assuming, in some degree, the function of glandular epithelium, to compensate for the waste of the proper secreting portion of the gland.

Another portion of the tubes, which, according to my observations, seldom contains much fat, is the expanded portion, which, as Mr. Bowman has shown, forms the investment of the Malpighian plexus. Mr. Bowman describes the epithelium of this expanded portion of the tube as extremely delicate, and in some cases scarcely visible, being little more than a rudimentary representative of the epithelium of the tubes. In accordance with this, I have observed that when the tubes are completely gorged with oil, the Malpighian capsules are either entirely free from this material, or they contain only a few particles scattered over their interior: in some cases, one or two epithelial cells may be quite full, but I never observed a complete engorgement of the Malpighian capsule, and I believe it may be stated in general terms that the Malpighian bodies are the parts of the secretory apparatus, in which the deposit is least abundant in cases of Bright's disease. The accumulation of fat within the capsule does not appear to attain such a degree as to exert destructive pressure on the vessels of the Malpighian tuft.

It may now be well to inquire how far the changes which the kidney undergoes during the progress of Bright's disease, and the symptoms by which these changes are attended, admit of explanation.

It will be necessary to consider for a moment the manner in

which the vessels are arranged in the kidney, and the nature of the Malpighian bodies, as demonstrated by Mr. Bowman, in his admirable paper, "On the Structure and Use of the Malpighian Bodies of the Kidney."* The arrangement of the vessels in the kidney, and the circulation through the gland, may be thus briefly described: a small terminal twig of the artery pierces the dilated extremity of the urinary tube: within the capsule thus formed by the expansion of the tube, the artery breaks up into a capillary plexus, which Mr. Bowman has named the *Malpighian tuft of capillaries*; these capillaries again unite into a single *efferent* vessel, which passes out through the capsule, and goes to form another plexus, which immediately *surrounds the urinary tubes*. The course of the circulation then is from the artery into the Malpighian plexus, which lies *within* the dilated extremity of the urinary tube, and from this plexus through the efferent vessel into the capillary plexus, which lies *external* to the tubes amidst their coils and convolutions.

Any one having a clear conception of the anatomy of the kidney cannot fail to perceive the effect upon the circulation through the gland, which must result from the changes which I have described as primarily and essentially constituting Bright's disease of the kidney. The fat accumulates in the epithelial cells to such an extent as to produce engorgement and dilatation of the cells, and of the tubes which are lined by them; the consequence is, compression of the capillary plexus surrounding the tubes, giving rise to congestion of the Malpighian plexus. This passive congestion of the Malpighian plexus leads to transudation of the serum of the blood, and sometimes to rupture of the delicate vessels of the plexus, and the consequent escape of the colouring matter and fibrin of the blood. These constituents of the blood pass into the tubes, and so become mixed with the urine. Their escape from the blood-vessels is the result of a mechanical impediment to the return of the blood consequent on

* Philosophical Transactions, 1842.

compression of the veins by an accumulation of fat in the tubes.

The influence of a mechanical impediment, in giving rise to the escape of serum and of blood, and their appearance in the urine, is admirably shown by the ingenious experiments of Dr. Geo. Robinson, the details of which have been communicated to this Society, and published in its Transactions.* Dr. Robinson tied the renal vein in rabbits, the result of which was the appearance of albumen and of blood in the urine; the same consequences followed the partial or slow obliteration of the vein.

It is important here to remark, that a mechanical obstacle to the circulation of the blood through the heart or lungs, may give rise to venous congestion of the kidney, and the consequent presence of serum and of blood in the urine. I have had an opportunity of examining the kidneys of two subjects, in both of whom there was albuminous urine, and in one case dropsy during life. In neither case was there a trace of any organic disease of the kidney, but in both cases there was cardiac disease and great congestion of the lungs. In one case, the medullary portion of the kidney was slate-coloured from congestion, and this congestion extended down the ureter, clearly proving the cause of it to be external to the kidney: the Malpighian tufts were also much congested.

The red spots visible on the surface of the kidney in some cases of Bright's disease, and which have been erroneously supposed to be dilated Malpighian bodies, were first shown by Mr. Bowman to be "nothing less than the convolutions of a tube filled with blood, that has burst into it from the gorged Malpighian tuft at its extremity."—(See fig. 15.)

The mechanical compression of the vessels and the impeded circulation of the blood is the cause of the tortuous, dilated, and varicose condition of the veins and arteries which is often seen on the surface of the kidney, and which is well represented in the first of Dr. Bright's plates.†

* Vol. xxvi.

† Medical Reports, vol. i.

Another proof of the compression to which the vessels are subjected during the progress of Bright's disease, is the difficulty of injecting the cortical portion of the gland, and the small number of vessels, and of Malpighian bodies, which are seen when thin sections are examined with the aid of a microscope. In fact, the vessels become compressed, and many of them entirely obliterated; and here we have an explanation of the wasting which the kidney undergoes in advanced stages of the disease.

There is a remarkable difference in the effect produced upon the two organs—the kidney and the liver, by an accumulation of fat in their substance; the function of the kidney becomes seriously interfered with, and its nutrition impaired, while the liver appears to suffer but little, either in its nutrition or its functions. In order to explain this diversity, it is sufficient to consider attentively, and compare, the anatomy of the two organs.

The explanation which Mr. Bowman has given of the comparatively little influence which the fat in the hepatic cells exerts upon the circulation through the gland, is probably the true one. The secretory cells of the liver seem to be, as it were, packed in the meshes of the capillary vessels, so that the engorgement of the cells by fat may produce great enlargement of the liver, without any material change in the relative position of the cells and vessels.

In the kidney, the arrangement of the vessels is such, that they must inevitably suffer serious compression from any distension or bulging of the tubes. Each convoluted tube, with its external plexus, and the Malpighian plexus contained within its dilated extremity, may be looked upon almost as a separate gland; each Malpighian tuft being, as Mr. Bowman has shown, a terminal isolated part of the arterial tree. The dilatation of a single convoluted tube might so compress the plexus by which it is surrounded, and thereby so much oppose the escape of blood from the Malpighian plexus, as to give rise to the bursting of its delicate vessels, in consequence of which the supply of arterial blood to the tube would be

cut off; and a less degree of congestion might so far diminish the direct supply of blood, as to lead to the atrophy of the tube in which the obstruction originated.

Another peculiarity in the structure of the kidney, which, doubtless, contributes to the destructive influence of dilatation of the tubes upon the blood-vessels of the organ, consists in the presence of a fibro-cellular matrix, in the form of a regular net-work, the meshes of which have a circular outline (see fig. 14). In the smaller spaces the tubes are packed, each tube in its course being surrounded by many of these fibrous rings, while in the larger spaces are contained the Malpighian bodies. The vessels constituting the "portal plexus" of the kidney are contained in the substance of this fibro-cellular tissue. Since the tubes naturally fill very accurately the spaces in which they are contained, it is evident that a dilatation of the tubes will lead to compression of the fibro-cellular net-work which surrounds the tubes, and of the vessels contained within this tissue. This tissue presents a resisting point, against which the distending force within the tubes may act, and the dilated tubes become constricted, as it were, by ligatures of fibro-cellular tissue, the vessels contained in the substance of the tissue at the same time suffering so much compression that the circulation through them must be greatly retarded or entirely arrested. An obstruction in this part of the circulation re-acts upon the Malpighian tufts; hence congestion of the delicate Malpighian vessels and effusion of serum into the tubes, or even rupture of the vessels and hæmorrhage into the tubes, and subsequently wasting of the tubes themselves.

Without anticipating what will presently be said of the pathology of Bright's disease, I will here offer a few remarks on its stages and forms; and, first, I will venture to assert that there is no inflammatory or congestive stage *preceding* the deposit. The congestion which often accompanies the disease, and which is a consequence of previous morbid changes, may be either active or passive. The way in which passive congestion occurs has already been sufficiently ex-

plained. Active congestion may be thus accounted for:—a large number of the epithelial cells become gorged with fat, and their secreting function is in consequence impaired: those portions of the gland which are less involved in the disease are now called upon to do an increased amount of work; this may lead to active congestion, and the consequent effusion of serum and blood into the tubes. In many cases there probably exists both active and passive congestion of the vessels; but I repeat that this is the *consequence,* and not the *cause,* of the deposit in the gland.

Dismissing, then, a congestive stage, the earliest appearance of fatty degeneration of the kidney would, of course, be recognised by the aid of the microscope before the gland has undergone any change visible to the naked eye. As the accumulation of fat increases, the kidney becomes granular or "mottled" on the surface. The smooth, mottled kidneys are such as have the greater number of the tubes in the cortical portion almost uniformly gorged; the gland is often much increased in size by the great amount of fat in the tubes, the vessels are much compressed, and the surface of the kidney sometimes presents an almost uniform yellowish white colour, with here and there a few vessels which have escaped obliteration. (See 4th plate in 1st volume of Dr. Bright's Reports.) These are generally cases which have run a comparatively rapid course. The secreting function of the kidney has become greatly impaired, and death has been the consequence. The kidney which has arrived at this degree of fatty engorgement, probably never becomes atrophied.

The *granular and atrophied* (Bright's) kidneys are those in which the accumulation of fat takes place less rapidly and uniformly; some convoluted tubes become gorged with fat, forming prominent granulations; and these, compressing surrounding parts, produce obliteration of the vessels and atrophy of the tubes, and thus the entire gland gradually wastes and contracts. These are the cases in which the tubes of the pyramids become filled with fat, part of which, perhaps, has been carried into them from above, while part is contained

in their own epithelium, which, perhaps, (as has already been suggested,) assumes a more active secretory office in consequence of the wasting of the cortical portion of the gland.

I do not maintain that every atrophied kidney, and every kidney presenting a granular appearance, have undergone these changes in consequence of fatty degeneration of the gland; on the contrary, I am well aware that many instances of granular and contracted kidneys are met with, in which the degeneration has been of a totally different kind, and I am also in a position to show that these are not cases of true Bright's disease; that they belong to a class of diseases which the best pathologists have always endeavoured to distinguish from Bright's disease, although, in the absence of any accurate means of definition, diseases totally and essentially different in their nature have often been confounded under one name. (See Appendix, page 22.)

Before speaking of the pathology of Bright's disease, it is important to consider briefly the diseases with which it has been found to co-exist. Dr. Bright appears to attach but little importance to the morbid states of the liver, which he considers to be of comparatively rare occurrence in connection with this form of renal disease; but, on the contrary, the observations of Dr. Christison, M. Rayer, and several other pathologists, have shown that some form or other of liver-disease is a very frequent concomitant of Bright's disease of the kidney. So far as I have been able to ascertain, no pathologist has given any very definite account of the *kind* of liver-disease most commonly associated with Bright's disease.

My own observations have led me to conclude that, in by far the greater number of cases, Bright's disease, or fatty degeneration of the kidney, is associated with a similar fatty degeneration of the liver.

Since the commencement of July, I have made a *post-mortem* examination of 22 cases of Bright's disease of the kidney; and, in 17 of these, there was, in a most marked degree, fatty degeneration of the liver. The liver was com-

monly enlarged, sometimes to a great degree, frequently of a pale yellowish colour, dotted with brown or red; more commonly, however, presenting a nutmeg appearance. Under the microscope, the secreting cells were seen gorged in various degrees with their increased fatty contents; and, in addition, there was much free fat which had escaped from the ruptured cells. (I would here remark, that the quantity of fat in the liver cells, as well as in those of the kidney, varies considerably within what may be considered the limits of health. When I have observed the fat in the liver cells unusually abundant, yet not so much as amounts to complete engorgement of any considerable number of the cells, I have noted the fact, but have not recorded the case as one of fatty degeneracy of the liver.) It has already been stated that there co-existed with Bright's disease, fatty degeneration of the liver in 17 cases out of 22. In 4 of the remaining 5 cases there was a decided increase of fat in the hepatic cells; and in one case only was there no such increase. During the same period I met with only 4 cases of fatty liver which were *not* combined with Bright's disease of the kidney. In 3 of these cases, although there was not a decided fatty degeneration of the kidney, there was still a marked increase of fat in the epithelial cells of this gland. In the fourth case of fatty liver there was *no* increase of fat in the kidney.

Of 23 cases in which both the liver and the kidneys might be considered *healthy*, there was an unusual quantity of fat in *both* organs in 4 cases, in the *liver alone* in 2 cases, in the *kidney alone* in 2 other cases; while, in the remaining 19 cases, the fat existed in what might be considered the usual quantity in *both* organs. In making these observations I have been most careful to avoid every source of error, and I am confident that very similar results will be obtained by every careful observer who will direct his attention to this subject. It is needless to remark how important is a knowledge of these facts in any attempt to explain the pathology of Bright's disease.

It has been fully established by the observations of Dr. Christison, MM. Solon and Rayer, and of many subsequent

observers, that Bright's disease is very frequently associated with tubercular disease of the lungs. Among the 49 cases from which my preceding observations are drawn, there were 14 in which tubercles were found in the lungs. Of these 14, there were six in which there was decided fatty degeneration of both the liver and the kidneys. In one case the *liver alone* was fatty, in one the *kidneys alone,* and, in the remaining 6 cases, there was either *no* increase of fat in the liver or kidneys, or the increase was not so great as to be considered morbid; so that, out of 21 cases of fatty degeneration of the liver, 6 only occurred in connection with tubercular disease of the lungs, while 17 occurred in combination with fatty degeneration of the kidney. The number of observations, I am aware, is too small to enable one to state exactly in what proportion of cases the different combinations to which I have alluded may be expected; but I feel assured that future observers will confirm my own conclusion that fatty degeneration of the liver in different degrees is more commonly associated with Bright's disease of the kidney than with tubercular disease of the lungs.

It has been shown by Dr. Bright and other observers, that, in subjects who die of Bright's disease, the arteries are very commonly affected by those changes to which the terms *atheroma* and *steatoma* have been applied, and which Mr. Gulliver has shown to be a fatty degeneration of the vessels, commencing apparently in the lining membrane, and extending to the deeper tissues.* According to my own observations, it rarely happens that a patient dies of Bright's disease of the kidney without presenting more or less of this fatty degeneration of the arteries. In some cases the degeneration is confined to a few small opaque whitish or yellowish patches in the aorta, while, in others, the disease is very extensive, and affects many of the smaller arteries. This fatty degeneration of the arteries is by no means confined to subjects who are affected with Bright's disease; on the contrary, it is in various degrees an extremely common morbid appearance in persons above the age of 30 who die in the London hospitals.

* Med. Chir. Transactions, vol. xxvi.

It is well known that another frequent concomitant of Bright's disease is hypertrophy of the heart, either with or without valvular disease. The condition of the valves which I have frequently found in cases of Bright's disease, as well as in other cases where there has been no history of rheumatic attacks, has been precisely the same fatty degeneration as occurs in the arteries. Opaque yellow thickening commencing in the investing membrane, and involving the deeper fibrous parts; and this, when examined microscopically, is found to consist entirely of fat, part of which is in the form of free oil globules, while part is contained in cells.

It has been too much the custom to consider all cases of valvular disease, occurring in the earlier periods of life, as the result of rheumatic inflammation of the endocardium. It is most important to be aware that the investing membrane of the valves is liable to the same fatty degeneration as that of the arteries; that the tendency to this disease probably increases in advanced life, but that, in certain conditions of the system, it may occur in the earlier periods of life as one of the consequences of disordered assimilation.

There is one circumstance which Mr. Gulliver does not mention in his paper. I allude to the fact that a certain quantity of fatty matter, varying considerably in different cases, exists constantly in the lining membrane of the *healthy* arteries as well as in that covering the valves. It was not until I had examined the arteries and valves in a considerable number of subjects that I became aware how much fat might exist in these parts without any morbid appearance visible to the naked eye. I think it by no means improbable that, in some of these cases, in which the microscope detects an unusual amount of fat, but which is not sufficiently abundant to constitute any decided morbid appearance visible to the naked eye, this circumstance may be considered an indication of a general perverted nutrition of the artery, by which, probably, its elasticity is impaired. And perhaps in this way may be explained some of those cases of hypertrophy and dilatation of the heart which are not accounted for by the

existence of any visible obstacle to the circulation either at the orifices of the heart or in the course of the arteries.

Let us now look back upon the ground we have gone over. We have seen that, in subjects who die of Bright's disease of the kidney, there is usually found a similar disease in the liver, and, in many cases, in the arteries and on the valves of the heart; the disease being in every case an increase and an accumulation of a material which exists in small quantities in the healthy condition of these parts.

In any attempt to explain the *pathology* of these diseases, their source must be looked for in the processes of digestion and assimilation. The processes of primary or secondary assimilation, or both, fail with regard to this fatty matter, which, not undergoing the changes requisite for its ready elimination from the system, or for its application to the nutrition of the tissues, is thrown into the circulation. An effort is made to carry it off by the liver and kidneys; the fat finds its way into the secreting cells of these glands; its escape from these parts, in a free state, is a slow and uncertain process, and, finding no material in sufficient quantity with which to pass off in a state of combination, the fat accumulates in, and obstructs, the glands.

The increased amount of fat in the secreting cells of the glands must certainly be looked upon as an *effort* to carry off this material. It must also be looked upon as, in a great degree, an *unsuccessful effort*. It will presently be shown that the quantity of uncombined fat in the urine in cases of Bright's disease is seldom greatly increased. As far as regards the result of her effort, then, Nature is as unsuccessful in her attempt to carry off the fat by the glands as to remove it by throwing it into the arteries. In both cases the fat is thrown out of the circulation, but its accumulation in the glands and arteries leads to a serious interference with the functions of these parts.

The conditions under which these diseases occur may be looked upon as analogous to those which give rise to diabetes. In diabetes, in consequence of imperfect digestion or mal-assi-

milation, sugar is eliminated in various excretions, but especially in that of the kidneys. Again, in the cases in which fatty degeneration of the liver and kidneys occurs, an effort is made to eliminate fat; the sugar being soluble, is readily carried off; the fat being insoluble, and consequently difficult of elimination, accumulates in the secreting cells of the glands.

Most pathologists are agreed as to the conditions which favour the development of Bright's disease. It is known to be much more common in large towns than in the country, and in large towns it is much more prevalent among the intemperate, ill-fed, and ill-clad inhabitants of cellars, and other imperfectly aired and lighted apartments, than among those who enjoy more of the comforts of life. I am indebted to my friend, Mr. Simon, for the opportunity of mentioning an interesting example of the disease artificially produced in one of the lower animals. In the course of some experiments on the artificial production of scrofulous diseases in the lower animals, Mr. Simon inspected the body of a cat which had died after having been kept for about six weeks in a dark cellar. On examining the kidney, he found that it presented to the naked eye the appearance of a mottled Bright's kidney, and on placing a portion under the microscope, he ascertained that the tubes of the cortical portion of the gland were completely gorged with fat. The liver cells also contained a great increase of fat; but their engorgement with this material was less than that of the kidney cells and tubes.

It is commonly supposed that Bright's disease may commence in an attack of what has been called acute inflammatory dropsy. But here some caution is necessary. After the proofs which have been adduced of the constitutional nature of the disease, it must be evident, that whatever circumstances tend to produce it, must do so by acting otherwise than locally. It is by disturbing the healthy balance of the digestive and assimilative processes, that the intemperate use of spirits acts as an exciting cause of this renal disease, and not by any local irritating effect upon the kidney or liver.

Exposure to wet and cold, and the consequent suspension of the cutaneous functions, may give rise to congestion of the kidneys, scanty, albuminous and bloody urine, and dropsy. But if the patient so attacked was previously of sound constitution, and if he be treated actively, with a view to restore the functions of the skin, to relieve congestion of the kidneys, and to carry off the accumulated fluid by the bowels, the dropsy and the other symptoms will disappear, and the patient will be restored to perfect health. Such an attack has no tendency to terminate in Bright's disease, which, it cannot be too often repeated, is not primarily a disease *in* the kidney, but a constitutional disease, manifesting itself *at* the kidney.

It is very generally believed that Bright's disease may have its origin in an attack of dropsy supervening upon scarlatina. It seems to me that this notion must be accepted with some modification. I have lately had an opportunity of examining the kidneys of three patients who died after an attack of scarlatina. In two of these cases there was albuminous urine, and in one there was dropsy, but in no case did the kidney present any of the characters of Bright's disease. In one, there were no morbid appearances whatever; in a second, there were unequivocal *products of inflammation*; and, in the third, there was great congestion, with blood in the tubes, and other appearances which seemed to indicate an increased amount of functional activity in the organ.

The conclusion which I draw from the preceding facts is, that the dropsy which supervenes upon scarlatina does not depend on Bright's disease, and that if scarlatina ever leads to the development of Bright's disease, it must be through the medium of those constitutional disturbances which would probably at the same time give rise to a similar disease of the liver. I look upon the dropsy occasionally arising during or after an attack of scarlatina, as the result, *partly*, of the cutaneous disease, but *chiefly* of some *materies morbi*, striving for elimination by the kidneys no less than by the skin; and which, in its passage through the former organs, acts as an

irritant, giving rise to active congestion of the kidneys, and the consequent effusion of serum and blood into the urinary tubes.*

Some pathologists entertain the notion that the cardiac disease, which is so commonly associated with the renal, precedes the latter, and so, by inducing congestion of the kidney, gives rise to Bright's disease. This idea will probably prove to be an erroneous one. It is supposed by others that the valvular disease originates in the morbid and irritating condition of the blood consequent on the impaired function of the kidney. It is not improbable that some of the changes which the valves undergo may have their origin in this condition of the blood; but, as has already been mentioned, the condition of the valves which appears to be most commonly associated with Bright's disease, is that of fatty degeneration, which is probably a result of the same common condition as that which gives rise to the renal disease.

I will here offer a few remarks on the microscopical characters of the urine in health and disease.

The presence of fat in the epithelium of the healthy kidney would naturally lead us to expect its occasional appearance in the urine. The existence of oil in healthy urine has probably been noticed by many observers. It is mentioned by Henle. Professor Miller assures me that he

* Since the above was written, I have had an opportunity of examining some well-marked specimens of renal disease occurring as a consequence of scarlatina. The result of these examinations quite confirms me in my opinion that the disease is essentially distinct from Bright's disease; that it is, in fact, an inflammation of the kidney, excited, like the inflammation of the skin which constitutes the eruption of scarlatina, by the passage through the part, of the peculiar fever poison; and as the inflammation of the skin terminates in an excessive development of epidermis and a desquamation of the surface, so the inflammation of the kidney excites an increased development of the epithelium which lines the urinary tubules; this material partly accumulates in, and chokes up, the tubes, while part of it becomes washed out with the urine, and may be detected in large quantities in that fluid by the aid of the microscope. The particulars of this and of other forms of acute and chronic inflammation of the kidney, I purpose to make the subject of a separate communication.

has seldom or never found it entirely absent. I have repeatedly noticed it in the urine of persons whom I had every reason to consider free from renal disease. I believe, however, that its presence in healthy urine will be found not to be a constant occurrence.

It is not improbable that a certain proportion of fatty matter, in a state of combination with some other material, is constantly eliminated from the healthy kidney. The existence of fatty matters as a normal constituent of the urine, is cursorily alluded to by Berzelius, Simon, Scharling, and other chemists, but it has not received that degree of attention which its importance appears to demand.

In Bright's disease, the urine occasionally contains a great increase of fat, but this is by no means a constant, nor, I believe, a very common occurrence. Simon, in his "Chemistry of Man," states that in some chronic cases of Bright's disease, the urine is turbid from the presence of fat.

It is well known that Dr. J. Franz Simon first directed attention to some cylindrical bodies which he had observed in the urine of patients affected with Bright's disease. These bodies are without doubt coagulated fibrin, which has become moulded into the urinary tubes. They often contain blood-discs, nuclei, and fragments of epithelium, and some of them, as I have repeatedly seen, entangle oil globules and cells, containing variable quantities of fat (see figs. 10, 11, and 16, which represent these fibrinous casts).

Epithelial cells containing fat are frequently seen in the urine, even when the fibrinous casts are absent (see figs. 12 and 13). These cells have evidently been washed from the urinary tubes by the current of urine, and their presence in the urine may be looked upon as one of the most certain signs of the existence of Bright's disease. Their diagnostic value is evidently greater than that of the fibrinous casts, since the latter merely indicate a hæmorrhage from the urinary tubes, which may result from more than one disease of the kidney, or from conditions altogether unconnected with renal disease; whereas, the presence in the urine, of epithelial

cells gorged with fat, indicates a condition of the kidney which is known to be characteristic of Bright's disease.

After Mr. Simon had ascertained that the cat which had been confined in the cellar was affected with Bright's disease, I assisted him in examining, from time to time, the urine of two other cats which had also been subjected to long confinement. In our first examinations we found that the urine of both animals contained a considerable quantity of free oil globules, as well as epithelial cells enclosing various quantities of oil, some cells being completely gorged. At this time there was no albumen in the urine of either animal; but we found, from time to time, that the fat in the urine of one was diminishing, until, at the end of three weeks, it was very small in quantity: and now, on the application of heat and nitric acid, the urine became turbid from coagulated albumen. The animal was then killed, and its kidneys were found in an advanced stage of Bright's disease. There was no decided increase of fat in the liver.

The fat in the urine of the other cat continued abundant a few days after the death of its fellow, when it suddenly decreased, and some inflammatory products appeared in the urine. The animal was killed: the kidneys and liver were extremely fatty; the mucous membrane of the bladder was softened, and apparently ulcerated in one patch. This, evidently, was the source of the inflammatory products in the urine, and perhaps of the albumen, which appeared simultaneously with the former.

These observations are peculiarly interesting; demonstrating as they do, in a striking way, the conditions which give rise to these fatty degenerations of the liver and kidneys. They are also interesting, on account of the proof which they afford, that the escape of the serum of the blood with the urine is not an essential consequence of the morbid process going on in the kidney; and that it is only when the mechanical obstruction to the circulation in the kidney has attained a certain degree that the constituents of the blood escape with the urine.

There seems reason to believe, that as with the cats, so with the human subject, a greater quantity of oil escapes with the urine during the earlier stages of the disease than in the later periods, when the tubes are more uniformly choked by their accumulated contents; and that in the presence of cells containing enlarged oil globules we shall have a most important sign of the very approach of the disease; one which will give us timely counsel to resort to such means as appear best calculated to arrest the approaching mischief.

In the *treatment* of Bright's disease, with its many complications, it must not be forgotten that the renal disease is a local manifestation of a general constitutional disorder, the removal of which must be attempted, not by the exhibition of violent and depressing medicines, but by strict attention to all those circumstances which are commonly included under the term "hygiene." Pure air, regular exercise, attention to the proper cleanliness and temperature of the skin, with the administration of chalybeate, and such other tonics as circumstances may seem to require—these are the means best calculated to invigorate the system, and so to restore the healthy balance of the functions. In addition, the diet of such patients will require careful regulation; and as a diabetic patient would be cautioned against the use of sugar, so, on the same principle, should the subject of these fatty degenerations be directed to abstain from a fat diet, and from an excessive use of such materials as starch and sugar, which seem difficult of digestion, and which may, perhaps, by a slight chemical change, be converted into fat.

The kidneys will require some special treatment, with a view to relieve congestion, which necessarily interferes more or less with the function of the gland, if it do not increase the tendency to fatty accumulation. The best means of relieving the congested condition of the kidney will be the regulation of the functions of the skin and bowels. Local bleeding may sometimes be called for, and it is a measure often followed by great relief and a manifest improvement in

the secreting power of the kidney; but in the use of this measure we must exercise that degree of caution which is required of us, when we remember the pathological history of the disease with which we have to deal.

I take this opportunity of mentioning that my friend and former fellow-student, Dr. Inman of Liverpool, has compared the specific gravity of the healthy kidney with that of kidneys affected with Bright's disease. The average sp. gr. of the healthy kidney he finds to be about 1046; while in Bright's disease he has found the sp. gr. as low as 1015.

If the object of the preceding pages has been accomplished, I hope to have established, to the satisfaction of the Society, the following points:—

1. That the epithelial or secreting cells of the healthy kidney contain a certain quantity of oil; the proportion of which, under certain circumstances, and within certain limits, may fluctuate considerably.

2. That it is an excessive increase of this fat, leading to engorgement of the epithelial cells, and of the urinary tubes, which constitutes primarily and essentially Bright's disease of the kidney.

3. That the presence of albumen and blood in the urine, and the wasting of the tissue of the kidney, are secondary phenomena, dependent on the mechanical pressure of the accumulated fat.

4. That in the majority of cases, Bright's disease is associated with a similar fatty degeneration of the liver and arteries, and frequently of the valves of the heart; these diseases being related to each other as joint effects of one common constitutional cause.

5. That probably acute inflammatory dropsy, occurring in a person previously healthy, and the dropsy which occasionally supervenes upon scarlatina, have no necessary connection with Bright's disease of the kidney.

6. That most important evidence of the approach and presence of the renal disease may often be derived from a microscopical examination of the urine, in which will be found

fat in unusual quantity; partly in the form of free oil globules, and partly contained in epithelial cells which have escaped from the urinary tubes.

7. That the insight which we have obtained into the peculiar change which the kidney undergoes in Bright's disease, and the knowledge we possess of the simultaneous occurrence of a similar change in other organs, may serve as important guides in the prevention and cure of the disease.

In conclusion, I have to acknowledge my obligation to those gentlemen who have assisted me in obtaining specimens of diseased structure. To Mr. Hewett, of St. George's Hospital, I feel myself peculiarly indebted, for his readiness in giving me access to his admirable record of *post-mortem* examinations made at St. George's, as well as for his kindness in procuring for me, and sending me, specimens.

APPENDIX.

In the preceding communication it will be seen that I have used the terms "Bright's disease" and "fatty degeneration" of the kidney synonymously; and I doubt not that the profession will agree in the propriety of thus restricting the former of these two terms. The term "Bright's disease" has frequently been applied in the most vague and indefinite manner, not only to almost every form of renal disease, but to cases of "albuminuria," quite unconnected with disease of any kind in the kidney. Most pathologists, however, have acknowledged the importance of distinguishing what they have called "true Bright's disease," or "true granular degeneration," of the kidney, from those comparatively infrequent forms of renal disease which they suppose to result from simple inflammation. Rayer believes, that in the presence or absence of albuminuria we have a test by which to dis-

tinguish Bright's disease, or, as he calls it, "albuminous nephritis," from simple chronic inflammation. I believe that Rayer's test will fail in most cases, and that the only one to be relied upon, is the minute anatomy of the diseased product. In the microscope we have a means of distinguishing the fatty from the acute or chronic inflammatory conditions of the kidney, not only after the death of the patient, but in most cases, and with great certainty, during life, and while the disease is in progress.

In conclusion I have to state, that at the commencement of August, when my paper was received by the Society's Secretary, I was not aware that any observations on the minute anatomy of Bright's disease, in any degree resembling my own, had previously been published; nor at the very full meeting of the Society in November, when my paper was read, did any one present appear to be aware of the fact that, so far as regards the mere sight of fat in some cases of renal degeneration, I had been anticipated by more than one observer. The most important observations with which I am acquainted are those of Hecht (de renibus in morbo Brightii degeneratis; Berlin, 1839), Gluge (Anat. Microsc. Unters.; Jena, 1841), Henle (Henle und Pfeufer, Zeitschrift für rationelle Medizim 1842), Canstatt (de morbo Brightii; Erlangen, 1844), and Eichholtz (Müller Archives, 1845; and Medical Gazette, 1845). The above-mentioned authors agree with each other, and with myself, in the simple and very obvious fact, that, in some cases of renal degeneration, fat in large quantities is contained in the substance of the kidney: as to the situation of the fat, and the interpretation of the whole phenomena of the disease, I believe my own views differ essentially from those of any preceding observer.

EXPLANATION OF PLATE I.

Figs. 1 to 4.—Epithelial cells from a healthy kidney. No. 1 contains no oil; 2, 3, and 4, contain a few small oil globules in their interior. Magnified 400 diameters. See page 2.

Figs. 5 to 8.—Epithelial cells from a kidney affected with Bright's disease. The oil globules in these cells are much larger and more numerous than in those from the healthy kidney. Magnified 400 diameters. See pages 2 and 3.

Fig. 9.—Portion of one of the urinary tubes from a kidney affected with Bright's disease. The oil globules contained in the epithelial cells by which the tube is lined, are here seen through the wall of the tube. Magnified 400 diameters. See page 3.

Figs. 10 and 11.—Fibrinous casts of urinary tubes from the urine of a patient labouring under Bright's disease. Each cast entangles blood corpuscles, and a cell having a considerable number of oil globules in its interior. Magnified 200 diameters. See page 18.

Figs. 12 and 13.—Cells containing numerous oil globules from the urine of a patient labouring under Bright's disease. Magnified 200 diameters. See page 18.

Fig. 14.—Fibro-cellular matrix from a healthy kidney, showing one large oval space which contained a Malpighian body, and several smaller spaces of pretty uniform size, in which the convoluted urinary tubes were packed. The substance of the network is made up of fibro-cellular tissue inclosing blood-vessels. Magnified 45 diameters. See page 8.

Fig. 15.—One of the red spots on the surface of a diseased kidney, magnified 45 diameters. A Malpighian capsule and a convoluted tube are seen filled with blood that has burst into them from the gorged Malpighian tuft. See page 6.

Fig. 16.—Fibrinous cast of one of the urinary tubes from the urine of a patient affected with Bright's disease. Several scattered oil globules are seen entangled in the fibrine. Magnified 200 diameters. See page 18.

HISTORY OF A CASE

OF

LIGATURE OF THE LEFT SUBCLAVIAN ARTERY,

BETWEEN THE SCALENI MUSCLES,

ATTENDED WITH SOME PECULIAR CIRCUMSTANCES.

By JOHN C. WARREN, M.D.,

PROFESSOR OF ANATOMY AND SURGERY IN BOSTON, U.S.A.; HONORARY FELLOW OF THE ROYAL MEDICAL AND CHIRURGICAL SOCIETY OF LONDON, ETC. ETC.

Received August 21st—Read November 25th, 1845.

The history of an operation for the ligature of the subclavian artery would, at this period of surgical science, seem scarcely worthy the attention of the Royal Medical and Chirurgical Society. This operation has been performed many times, and the annals of this distinguished body contain not less than twelve cases, many of them performed by the most celebrated surgeons of the age. Some peculiar occurrences, or some important practical inferences, seem necessary, to justify me in calling the Society's attention to another case. That which I have the honour to lay before them possesses peculiarities, and will, I hope, afford some practical inferences.

Some of the more remarkable circumstances in this case have occurred in former instances of the operation of ligature of the subclavian artery, while others are strictly peculiar to it.

James Avery, on the evening of Dec. 23rd, 1843, while in a state of intoxication, slipped on the ice, fell, and struck his left shoulder against the kerbstone of the side walk. Being taken up by the bystanders, he was carried into a house, and surgical aid was called. His shoulder was found to be dislocated, and violent efforts were made to reduce the dislocation, but exactly in what manner the patient could not tell, excepting that he thought one person placed his foot, with a boot on, in the axilla. After various trials it was supposed that the dislocation was not reduced, and he was sent to the hospital for treatment.

On the next day, being examined by Dr. Hayward and myself, he presented the following appearances:—He was a large, heavy, short-necked, unhealthy-looking man. His left arm was much swollen; the left shoulder enlarged and ecchymosed, so that there was no distinction of parts, and, of course, it could not be determined whether his arm was dislocated or not. The motions of the arm were accompanied with great pain. The man's age was about thirty. In this condition of the parts it was necessary, in the first place, to accomplish the reduction of the swelling, and leeches with cold applications were employed for this object.

On the next day the swelling was so much reduced, as to enable us to decide that no dislocation existed.

During the night of the third day following, Dec. 28th, he was seized with a violent fit of coughing, in which he felt something give way in his shoulder, and presumed it was thrown out of place. The house-surgeon, Mr. Townsend, being called up to him, made an extension on the arm, by which it was, as he thought, restored to its situation. On the following morning we found his shoulder and arm very much discoloured and enlarged, the arm painful, and the patient much prostrated.

On Dec. 30th, it was discovered that the man had no pulse in his left wrist, and, by examination, none could be detected in any part of the arm. This loss of pulse must

have occurred on the night of the 28th, for before that period it had existed as usual. He now, for the first time, made it known that he had neither feeling nor motion in the arm. The loss of motion was entire, although he could, for the first five days after the accident, raise his hand to his head; there was no sensation below the scapulo-humeral articulation.

The swelling with the discolouration increased for the two or three following days, until it became enormous, the arm turning black in the axilla and on the inside of the biceps muscle. A vesication was noticed on the back of the fore-arm. The pulse in the sound arm was about 100. There was a pulsation above the clavicle of the affected arm, in the usual situation of the subclavian artery.

He went on quietly for some days, wholly confined to his bed by the weight and absolute immobility of his arm, when, on January 27th, 1844, a swelling was found to be forming in the axilla of the injured limb. This continued to advance with the appearance of a common abscess, excepting that the skin covering it was of a very dark colour. In seven days it pointed, and seemed ready to discharge, but did not till eight days after. On Sunday, Feb. 4th, it opened, and a gush of coagulum, with some fluid, dark-coloured blood was discharged, to the amount, it was thought, of about a pint.

Three days subsequently, namely, on Wednesday, Feb. 7th, at six o'clock in the morning, the patient being in bed, and not making any particular effort at the time, a sudden gush took place from the wound, by which the bed was at once inundated, the mattresses soaked, and blood was poured upon the floor at different points. Exhausted, and almost lifeless, he sunk into a state of syncope, and the hæmorrhage ceased. When we examined the man, a few hours after, he appeared very low; the pulse on the sound side was exceedingly feeble, not to be discovered in the injured arm, doubtful above the clavicle.

As he was at that time too low to undergo any operation, it was agreed that, if he lived to the next day, the subclavian

artery should, if possible, be tied. The great tumour of the shoulder above, and that of the axilla and arm below, by which the clavicle was forced upwards (for, notwithstanding the discharge of coagulum, the tumour in the axilla remained very large), rendered it doubtful whether it would be possible to get at this vessel above the clavicle, and below this bone the parts were too much deranged to admit of any operation.

By the next morning the patient had much revived; the pulse was more distinct, and a pulsation could be felt above the clavicle, in the place of the subclavian artery, as before stated. He lost a gill of blood in the morning, but not *per saltum.* At ten o'clock he took eighty drops of tincture of opium; at eleven, he was carried into the operating theatre, and an operation performed as follows, on Feb. 8th, 1844.

Drs. Hayward, Townsend, Lewis, Holmes, and Parkman, attended, and assisted in the operation. A great difficulty presented itself in the outset. In consequence of the swelling of the shoulder, the tumour in the axilla, and the natural shortness of the patient's neck, the space between the shoulder and the lower jaw was almost obliterated, the shoulder rising up so high that a line passed transversely from the acromion process across the neck, when he was lying flat on his back, with his head resting upon the table, crossed the face above the lower jaw. The patient therefore had a pillow placed under his shoulders, so that his head might be depressed as much as possible. His face was turned a little to the right side. Before making any incision, search was made for the external jugular vein, but it was too much contracted to admit of being discovered through the skin.

Placing my finger on the posterior edge of the sterno-mastoid muscle, three-fourths of an inch above the clavicle, I made a transverse incision about three inches long, of which the anterior extremity corresponded with the posterior edge of the sternal head of the sterno-mastoid, and the posterior extremity with the anterior edge of the trapezius; making the point where my finger was fixed the middle of the wound. The

fascia and platysma myoides were divided, and the sterno-mastoid exposed. The external jugular vein being uncovered, a branch running into it was divided, and tied; a temporary ligature was then passed around the vein, so as to draw it towards the outer part of the wound. In making these incisions, the blood, owing to its fluidity, flowed freely at every touch of the knife.

Perceiving the difficulties I should have to encounter, I at once divided the clavicular head of the sterno-mastoid muscle, and then proceeded with the handle of the knife to remove the adipose substance immediately above and behind the clavicle. The muscles were so pallid, that it was difficult to distinguish them from the surrounding textures; the omo-hyoid muscle could not be discriminated from the chain of lymphatic glands lying near to it.

Passing my finger down to search for the pulsation of the subclavian artery, I perceived, corresponding with the edge of the clavicle, a strong pulsation arising from an artery of large size. This being nearly in the situation in which the subclavian would be looked for, led me to hope for a moment that I felt the latter vessel. But this delusion lasted for a moment only, for I was immediately convinced by the rolling of this artery under the finger, that it was not the fixed, immoveable subclavian, but the supra-scapular artery. It was necessary to pursue the operation with great caution, lest this artery should be divided, as it would have been difficult to have secured it, and its loss would have deprived the arm of a most important source of supply.

After pursuing the dissection with the handle of the knife and the blunt director, I passed the finger down in order to discover the tubercle of the first rib, but neither tubercle nor rib could be felt at this or any part of the operation, and thus the most exact guide to the situation of the artery and the basis on which its pulsations could be discovered, failed to appear. With the end of the finger I cleared away the cellular texture, and at length discovered a faint pulsation, at the same time perceiving a cord, which I ascertained to be a

nerve; this was pushed aside, and then the pulsation being more distinct, I took this second cord, on which the finger rested, to be the subclavian artery. The aneurism-needle was then passed under the apparent artery, a ligature carried round it, and on drawing up this ligature, so far as I could judge the pulsation seemed to be suspended. On a repeated examination, however, the gentlemen around, as well as myself, were satisfied that the artery was not included in the ligature. This second nerve, which was the first dorsal, was to be removed from the surface of the artery, in order to expose the latter, but the wound was too deep, too narrow, and of consequence too dark to permit the artery to be visible. The anterior scalenus was partially visible, and passing the forefinger of the left hand to the edge of this, a good portion of the muscle was divided by the probe-pointed bistoury, introduced upon the finger. The subclavian artery then became quite sensible to the touch, and slightly distinguishable by the eye. A long aneurism-needle, with rather a short curve, was passed under the artery, and some little effort was required in turning the needle in this deep narrow wound, so as to bring the point to the opposite side of the artery. This was, however, soon accomplished, the ligature seized, and drawn out.

At this moment a slight whistling noise was heard, which I did not think of any consequence at first, having the impression that the movements of the needle had been so conducted, that the pleura could not possibly have been wounded. Being satisfied, afterwards, that some air had entered the thorax, I secured the ligature with a *serre-nœud*, in such a way that the artery should not be elevated from the surface of the wounded pleura and fascia covering it. Then bringing together the sides of the wound with the fingers, no more air entered, and no inconvenience was experienced from that which had been previously admitted.

At 5 P.M. I visited the patient, and found he had much uneasiness in the chest from the situation of his head, which was too low. I raised his head directly, and all uneasiness left

him, nor did he afterwards have a recurrence of pain in the chest, or complain of any other suffering. He was no sooner raised, and had expressed himself much relieved, than a loud knocking was heard, like a person striking his knuckles upon a table. This noise was perceived all over the ward of the hospital; I looked around to ascertain whence it proceeded, but presently suspected it came from the patient. I then placed my hand upon his chest, and found the heart knocking with great violence against the ribs. The phenomenon, which lasted two or three minutes, surprised me, the patient, and the bystanders, and I was at first at a loss to explain it; but on consideration, I think that it arose from a sudden re-action of the heart in an anæmic state, owing partly to the moving of the patient, and partly to a change in the capacity of the thorax, by which more room was given to the heart, and a pressure to which it had been for some hours subjected, was suddenly removed.

For some days the patient remained comfortable, without any particular alteration in his symptoms. His strength continued to improve steadily under a good diet, with the free use of tonics and stimulants; a large quantity of cordials being required by him, in consequence of the great loss of blood, and his previous habits of taking stimulants to excess. On the third day from the operation, three sutures, required in dressing on account of the gaping of the wound from the great enlargement of the parts, were removed, and the wound was found to have principally united. The swelling in the axilla discharged a quantity of bloody serum, but no pure blood. The arm, which had at first appeared to be in a state of partial gangrene, assumed a more healthy aspect, and the swelling gradually subsided.

On February 22nd, the thirteenth day from the operation, the ligature, being seized with the forceps, was found to lie loosely in the wound, and was removed. The pulse now ranged from 72 to 76. Although permitted to be raised in bed occasionally, for the purpose of changing his clothes, he

was not allowed any active motion, until more complete closure of the wound from which the ligature had been discharged. The returning sensation had extended from the shoulder to the elbow, and even into the fore-arm.

On the afternoon of February 29th, while engaged in quiet conversation, a stream of blood, about the diameter of a common quill, was seen to issue from the unclosed part of the wound. The house-surgeon being immediately called, applied a sponge, and sent for me.

I saw him in fifteen or twenty minutes after the occurrence: he was not then bleeding, and appeared not to be much exhausted by the loss of blood. The quantity lost was supposed by the attendants to have been about a pint. In the opinion of the house-surgeon, the blood did not issue *per saltum*, and was of a venous colour. When it is considered, however, that it issued from a cavity two or three inches in depth, and that the aperture of the artery being small, and perhaps not corresponding exactly with the aperture of the wound, the non-appearance of an arterial jet might be accounted for, although the artery were really open. I examined the wound, placed an additional piece of sponge within it, and, to support this, another sponge on the outside, two inches in thickness, which was retained in its situation by long adhesive straps. The patient was ordered to be kept perfectly quiet, to preserve an entire abstinence from solid food, and to use a liquid regimen sparingly for two or three days.

The pieces of sponge were allowed to remain about a week, and their removal, which was accomplished without force, was not attended with bleeding or pain. From the aneurismal cavity in the axilla, a slight hæmorrhage took place a day or two subsequently.

No further alterations occurred in his symptoms until the 11th of March, from which period until the 22nd he laboured under an attack of pulmonic inflammation, chiefly confined to the lower lobe of the left lung, accompanied with pain and soreness in the anterior part of the chest, shortness

of breath, cough, and some black expectoration. Notwithstanding this disease, finding that his strength was failing, I considered it necessary, taking into view his former habit of using spirituous liquors, to resume the administration of cordial drinks. He was also directed to be removed from his bed to another, and occasionally to sit up, for the purpose of producing a more uniform circulation, and thus preventing those congestions which are common to patients in his situation. The tumour in the axilla, which had for some time been increasing in size, now presented a darker aspect, became very painful, and emitted a highly offensive discharge. On March 21st it threw off a round, dark-coloured lump of old coagulum, about the size of a hen's egg, to the great relief of the patient. The discharge from the wound above the clavicle, which at this time was slight, afterwards increased so as to threaten to prove troublesome. At this period he displayed a great want of mental power, arising from the extreme debility produced by the discharge. About the 1st of May he had a second attack of congestive pneumonia, like the preceding, confined to the left side, from which he recovered in a few days.

In order to aid the restoration of the arm, for some weeks electro-magnetical shocks were passed through it with much benefit. By the 1st of October the tumefaction had disappeared from the arm, and motion had returned in the shoulder-joint, but not in the elbow or wrist; pulsation had not returned in any of the arteries of the arm; sensation had gradually crept downwards from the shoulder to the extremities of the fingers, although still imperfect in the latter. A portion of the internal condyle of the os humeri having become inflamed from pressure, was necrosed; a part of the bone separated, and the wound slowly healed. The large excavation in the axilla was reduced to a fistulous tube three inches long. The wound of the operation had contracted to the depth of an inch, and the discharge from it was very slight.

In nearly this condition he remained till the early part of

February 1845, his situation steadily, but slowly, ameliorating; the motion, strength, and sensation of the arm constantly improving, so that an electro-magnetical current passed through the affected arm was distinctly felt in the extremities of his fingers. On February 4th, 361 days after the operation, I was able for the first time to detect a distinct pulsation in the radial artery, and subsequently one of an indistinct character in the ulnar and brachial. By the 1st of April he could flex the fore-arm upon the arm, having recovered in a great degree the motions of the elbow-joint.

The patient now, June 15th, walks about freely both in and out of the house. There is still a fistulous opening in the axilla, and a slight one in the neck, extending an inch upwards from the clavicle, the cavity towards the artery being entirely healed. The sensation and motion are slowly improving. His appetite is generally good.

Remarks.

The cause of the rupture of the subclavian artery in this case is involved in some obscurity. The probability seems to be, that great violence was employed in the reduction of the dislocated humerus, and that the artery and nerves were contused by strong pressure of the operator's boot, combined with the forcible extension of the arm. The vessel did not rupture immediately, because its coats were contused and not torn asunder, but a separation of the contused parts took place in consequence of the violent efforts of coughing on the fifth day after the accident. This is the best hypothesis we can form on the subject, though not perfectly satisfactory, for the arm was so much swollen at the time the patient was first examined, that it was impossible to distinguish the effects of the accident from the effects of the force used to remedy it.

The loss of sensation at the time of the rupture of the artery may be attributed to the compression of the nerves from the prodigious effusion of blood into the cellular texture of the axilla and arm. The return of both sensation and motion must be attributed to the slow restoration of the nervous current after the compression was removed.

The next circumstance that presents itself in the course of the history is the formation of an apparent abscess in the axilla. The swelling occurred in a very gradual way, slowly increasing for at least twenty days, and assuming a pointed summit, which softened by degrees, and, for more than a week, threatened to open daily, seeming to invite the knife so strongly, that more than one intelligent surgeon was shocked at the apparent neglect of an incision. This had not, however, the aspect of a common abscess, nor had it exactly that of a sanguineous tumour, so that there was nothing to cause great alarm as to the primary effect of its opening. It was thought best, however, to leave it to be opened by the hand of Nature in a case so complicated, and having so many unfavourable circumstances.

The interval between the opening of the abscess and the occurrence of the great hæmorrhage—three days—might at first excite surprise, but this will cease when it is recollected that the cavity of the abscess and that of the aneurism were obviously distinct from each other; that the opening of the former would not necessarily involve that of the latter; and, in fact, we entertained strong hopes that the lacerated artery would be, or, to speak with more precision, actually was, plugged by an internal coagulum at the time the abscess opened. This might possibly have been the fact, and the cough, which still continued, might have forced open the lacerated artery, and thrown out the internal plug. The hæmorrhage which occurred from the aneurism was as great as the patient could support without expiring, and, through the day on which it happened, it was doubtful whether he could survive twelve hours. The operation for tying the artery was done as early as the circumstances of the patient would justify.

It was done on the emergency of the occasion, and, of course, without that preparation which surgeons desire when they are called on to do unfrequent and dangerous operations, although, in a lapse of years, I had had occasion to put a ligature on the subclavian artery in the dead subject more than a hundred times.

The admission of air into the pleura during the operation has happened to other surgeons. In such a case as this it would be difficult to take any course which would certainly avoid it; but I have adverted to it distinctly and repeatedly, that others, apprised of the possibility of its occurrence, may be better prepared to regulate their movements in such way as to avoid it.

Immediately after the operation, there was no circumstance worthy of remark, excepting that the arm, which was covered with cotton in the usual way, retained its natural temperature without any extraordinary precautions. This is the more remarkable, because the patient had lost a large quantity of blood the day before, and the function of the nerves of the limb was interrupted.

The occurrence of secondary hæmorrhage, twenty days after the operation, did not surprise me; for, although the patient appeared to be doing well at that time, yet the arm was in so dangerous a state from the paralysis, swelling, ecchymosis, threat of gangrene at various points, but, more than all, from the proximity of collateral arteries to the ligature, that I was led to place little confidence in the hope of this man's reocvery.

TWO CASES

OF

DISEASE OF THE BRAIN,

FOLLOWING THE APPLICATION OF A LIGATURE TO THE CAROTID ARTERY.

By JOHN P. VINCENT, Esq.,

SURGEON TO ST. BARTHOLOMEW'S HOSPITAL.

Received November 8th, 1845.—Read January 13th, 1846.

The two following cases appear to possess an interest that entitles them to be placed under the consideration of the Society.

James Mason, ætat. 48, in July 1829, was admitted into St. Bartholomew's Hospital, with an aneurismal tumour under his right ear. It had been forming eight months, and had considerably increased during the last fortnight; it was about the size of a small orange. On July 18th I tied the common carotid artery. The application of the ligature not only caused the pulsation in the tumour to cease, but to render it flaccid. When he was put to bed, he expressed himself to have become altogether easier than he had been, and to have lost the distressing pain in his head. In about an hour and a half after the operation, he was discovered to be slightly convulsed on the right side. He afterwards sunk into a state of stupor, and was roused with difficulty. His mouth was drawn to the right side; his pulse labouring and slow; he was bled to the extent of xxx oz., and the pulse then became freer. After this he became more sensible, and readily answered questions. He swallowed some tea with difficulty. He has now a slight cough, and is troubled with mucus in the trachea. He has twitchings of the right side; he was bled to xxx oz.

On the 19th he had dozed during the night; the twitchings of the right side have continued; he has no feeling on the left side—pulse 100. The cough and the mucus are troublesome, and he has difficulty of swallowing. He was bled to xvi oz., and in the evening he appeared to be better.

On the 20th he appeared to be much in the same state as on the previous day. He complained of pain on the right side of his head. He was again bled to xvi oz.

On the 21st he had a restless night. The twitchings not quite so violent; the paralysis of the left side has continued the same.

On the 22nd he had slept in the night. His urine had passed off involuntarily. Twitchings less—pulse 110. He swallowed with difficulty, but has not coughed. He expressed himself as feeling better.

On the 23rd he had had a quiet night, has swallowed better, and has not coughed. Has had no twitchings of the right side, the left side motionless. Pulse 110—regular.

24th. Much the same, he answers questions readily, and swallows easily. Has not been conscious of the passage either of his urine or stools. He quickly sunk from this time, and died in the evening.

Examination of the body.—The veins of the right side of the brain were not so filled out as those on the left. There were bloody points on the left hemisphere. The substance of the cerebrum on the right side was quite soft and cream-like. There was no deposit of blood in any part, but a little more serum in the ventricles than usual. The cerebellum was healthy. There were atheromatous deposits in the coats of the aorta.

On the 9th of April 1845, at 8 o'clock A.M., William Brown, ætat. 28, was admitted into St. Bartholomew's Hospital. At 3 o'clock the same morning he stumbled against a door, whilst smoking a pipe, which inflicting a

wound in the mouth, penetrated the lateral part of the root of the tongue, anterior to the right tonsil.

The pipe was broken into several pieces, one portion of which the patient felt with his fingers in the wound, but he was unable to remove it. Some bleeding, which occurred at the time of the accident, gradually subsided. The voice was husky. He complained of great pain, which was increased on attempting to swallow, or to open his mouth.

The wound presented a jagged appearance, and a probe could be introduced to the extent of three-fourths of an inch, in a direction downwards and backwards, but no foreign body could be detected. The parts around the wound, especially the tonsil, were greatly swollen; indeed, the tumefaction externally about the angle of the jaw was very considerable.

During the next five days the swelling and pain gradually increased, the former extending as low as the clavicle, and materially impeding the motions of the neck and of deglutition, so that he could take little nourishment. His tongue was covered with a pasty coating. The saliva he spat up was mixed with a little dirty and very offensive fluid. His pulse was small and weak. On the evening of the 5th day his breathing became noisy and difficult. On pressing the tongue, two drachms of pus escaped from the wound; but by fomentations, the pain, swelling, and difficulty of breathing in some measure subsided, so that with the aid of a few drops of laudanum, some tranquil rest was procured.

On the morning of the 16th, after having passed a quiet night, hæmorrhage suddenly took place to the extent of xxiv oz., which was arrested by my able and intelligent house-surgeon, Mr. Moore, who happened to be in the ward when the bleeding had just commenced. I was immediately sent for, and fearing that if the pressure was remitted, the hæmorrhage would prove fatal, I proceeded to tie the carotid artery.

This proceeding could not be accomplished without much difficulty, arising from the swollen and sloughing state of the parts, and from the effusion of blood and pus, which not only

prevented me recognizing the various tissues, but had materially altered the relation of the different parts; much caution was therefore necessary. Moreover, the excessive restlessness of the patient rendered the operation still more tedious. During the operation, the pressure on the carotid artery was relaxed, and as there was then no bleeding, it was entirely removed; but the swelling at the upper part of the neck again pulsated.

As soon as the ligature was applied to the carotid (which was done by my colleague, Mr. Wormald, who most ably assisted me throughout) $2\frac{1}{2}$ inches above the arteria innominata, the pulsation entirely ceased. It was observed during the operation, that the patient made violent efforts with his right side, but that he never moved the left extremities. After the operation, some brandy with laudanum was given him, which he swallowed without difficulty.

During the night he continued very restless, although he got some sleep, and the extremities of the right side were frequently convulsed. His pulse, which had been 132, sunk to 96. He got sleep in the morning, and took some beef-tea.

17th.—He has continued to sleep much; his pupils were contracted; his pulse 88, small and regular. The twitchings of the right side have continued; the paralysis of the left side has not been less. He had much difficulty in swallowing, which excited fits of coughing. Towards evening his pupils became natural, and he evinced more consciousness, and passed a quiet night.

18th.—He took beef-tea, generally without cough. He was less pallid, and said he felt better. The left side of his face now became paralysed. His pulse had risen to 115, and he had more power. The swelling at the upper part of the neck was softer and smaller.

About midnight, whilst coughing, arterial blood flowed through the nose and mouth; and from the wound of the neck a small quantity also escaped, which ceased on pressing the carotid above the clavicle. Although he had lost only an ounce of blood, he was considerably reduced in strength,

and the left foot was quite cold. He, however, again rallied, and knew those about him.

19th.—Although sensible when roused, his eyes remained half-open. He has talked a great deal, and constantly asked for drink. The left leg has recovered its warmth, and he has frequently moved his right arm towards his head. The irides acted when exposed to light. He had taken an opiate, but without effect.

On the 20th his pulse became more rapid and thready. Throughout the day he swallowed easily, and coughed but little. He was sensible, but lay with his eyes shut, occasionally throwing his right arm about. He took more nourishment, and in the evening he slept tranquilly.

About 2 o'clock A.M., on the 21st, a fit of coughing, with hæmorrhage to the extent of two or three ounces from his nose and mouth, terminated his existence.

Examination of the body twelve hours after death.—The wound in the neck presented a sloughy appearance. On reflecting the skin of the neck, the tissues were found to be much consolidated by lymph, and at the upper part, especially, the structures were obscured by sloughs, pus, and effused blood. At the bifurcation of the carotid on the right side, there was a large and firm coagulum, in the middle of which was the extremity of the tobacco-pipe, which had penetrated the artery at the point of division into external and internal carotids.

At the point where the artery had been tied, all the important parts around were imbedded in lymph, but uninjured and undisturbed by the operation. The jugular vein was closed to one-third of its usual size; its interior was healthy. A firm coagulum was found in the interior of the artery, above and below the ligature.

On opening into the longitudinal sinus, little blood was found, and the veins entering it were only partially filled. The arachnoid membrane was somewhat opaque, and beneath it serum was effused. The convolutions of the cerebrum on the right side were flattened and softened. On dissecting

the brain, irregularly-shaped cavities filled with ash-coloured effusion, with shreds and particles of a greenish hue, were discovered. One of these cavities was two inches in diameter, and encroached on the corpus striatum of the same side. From another, besides broken down brain, pus also issued.

I have only to add, what must be obvious, that if the portion of the tobacco-pipe had been detected at the time the patient was brought to the hospital, and withdrawn from its position in the wound, he must have died instantly, from the gush of blood that would have taken place, as this body seemed to have completely plugged up the artery. I understand that such a sudden fatal event has occurred under similar circumstances.

CASE

OF

PUNCTURED WOUND AND LIGATURE

OF

THE POSTERIOR TIBIAL ARTERY,

IN THE UPPER THIRD OF ITS COURSE.

By JAMES MONCRIEFF ARNOTT, F.R.S.,

SURGEON TO THE MIDDLESEX HOSPITAL.

Received November 11th—Read December 9th, 1845.

When an arterial trunk or main branch is wounded, the rule of practice is, that the vessel should be tied at the seat of injury; or, as it may be more truly expressed, when it can, it ought to be tied at the seat of injury, as the most certain means of arresting hæmorrhage; the qualification being rendered necessary by the fact that it is sometimes impossible, or is deemed inexpedient, to put the principle into practice. The circumstance which chiefly operates in creating an exception to the rule is the situation of the wounded artery; and it is this, no doubt, which has influenced those who, in punctured or gun-shot wound of the posterior tibial high up, have recommended other means of meeting the difficulties and dangers of the case.

A man was brought into Guy's Hospital, having fallen from a considerable height upon a cart. An iron peg in the cart had passed through the calf between the tibia and fibula, and a profuse hæmorrhage ensued; but by the application of a tourniquet, this was stopped. In six days the bleeding recurred, when the tourniquet was tightened, and the flow of blood again suppressed; but in two days, hæmorrhage again took place. Sir Astley Cooper tied the femoral artery at the

usual place, and for a week the man went on well, but then the bleeding was renewed, and Sir A. amputated the limb. On examining this after removal, it was found that the iron peg had passed through the posterior tibial artery, at the origin of the anterior tibial, and had penetrated between the tibia and fibula. Sir Astley adds, that "an immediate amputation would be the best course to pursue."* From information which I have received from one who witnessed this case, I have reason to believe that the patient did not recover.

An officer was wounded in a duel, the ball passing from before backwards, through the upper part of the leg, between the tibia and fibula, which was immediately followed by violent hæmorrhage. By the application of compress and bandage upon both openings, all further external bleeding was prevented until the 13th day, when it burst forth afresh, the leg having, in the mean time, swollen greatly at its upper part, attended with pulsation. The bleeding was renewed several times in a few days, when M. Dupuytren being called in, tied the femoral artery in the middle of the thigh, and the patient recovered.

Encouraged by the success of this case, M. Dupuytren was led to expect that it might be the forerunner of other similar fortunate results, and he recommends when the principal artery of a limb ruptured by a ball is followed by an extravasation of blood, presenting the character of an aneurismal tumour, that the artery should be tied at some distance from the wound, between it and the heart.†

On the other hand, Mr. Guthrie, a high authority in these matters, severely criticises the eminent French surgeon. He relates two cases which came under his own observation, of gun-shot wound of the leg, attended with hæmorrhage, where

* Lectures by Tyrrel, vol. iii. page 199. London, 1827.

† Mémoire sur les Anevrismes qui compliquent les fractures et les plaies d'armes à feu, et sur leur traitement par la ligature pratiquée suivant la méthode d'Anel. In the "Répertoire Général d'Anatomie et de Physiologie, tome v. 1828."

the femoral artery was tied. In one case the arterial hæmorrhage, which led to the ligature of the femoral, did not take place till a month after the receipt of the wound; in the other it occurred on the 8th and 9th days. In both, the ligature of the femoral arrested the hæmorrhage, but only for a few days, when it recurred, and led to amputation; in neither case with a favourable result, both patients having died. In one instance the anterior, in the other the posterior tibial artery had been wounded.

In another case of gun-shot wound of the leg, with hæmorrhage, Mr. Guthrie, fourteen days after the accident, cut boldly through the muscles of the calf, and tied the peroneal artery, which had been wounded, thereby saving the limb. He recommends that a similar proceeding should be adopted when the posterior tibial artery is wounded.*

This difference of opinion on the treatment to be pursued in case of wound of the posterior tibial artery high up, is not the only one in which this vessel is concerned. Another exists as to the mode of reaching the artery in this situation, should it be deemed expedient to tie it on account of aneurism or secondary hæmorrhage lower down. Some surgeons, with Mr. Guthrie, advise that the artery should be got at by cutting directly through the whole thickness of the muscles of the calf. Some, and the majority, recommend that it should be reached by incision made on the inner edge of the tibia, between this and the gastrocnemius muscle, which is to be pulled aside, so that the soleus muscle alone is divided. Others think even this operation beyond the domain of legitimate surgery, and consider both as adapted only for the dissecting room and the dead body, and not for the living.

That ligature of the femoral is an uncertain means for arresting hæmorrhage from the posterior tibial artery, is sufficiently shown by the three cases which have been adverted to.

That to reach the last-mentioned vessel in the calf by incision at the edge of the tibia, is attended with considerable

* On the Diseases and Injuries of Arteries. London, 1830.

difficulty, has been acknowledged by Mr. Harrison,* who witnessed the operation, and by M. Bouchet, of Lyons, who performed it: the latter surgeon was even obliged, in order to accomplish his object, to add a transverse incision of the soleus muscle.

The result of Mr. Guthrie's proposal has not, so far as I am aware, yet been ascertained. That gentleman informs me that, since his return to England, at the termination of the war in 1815, he has had no opportunity of putting his recommendation in practice, and I do not find that it has been tested by others. The difficulties and dangers which attend it upon trial in the living body remain therefore to be shown; and it is upon this account, and under these circumstances, that the case about to be related possesses any claims upon the attention of the Society.

Frederick Canacott, ætat. 18, chairmaker, a robust young man, whilst at work on the 1st January of the present year, was struck from behind by a $\frac{3}{4}$-inch joiner's chisel, thrown at him in anger by a fellow-workman. The chisel struck the calf of the right leg, penetrated deeply, and stuck there. On being withdrawn, great bleeding ensued, which was stopt by tying first one handkerchief round the leg, and then another, and grasping the parts over them. The occurrence took place in a street adjoining the hospital, where he was immediately brought, and where at the time I happened to be.

On uncovering the parts, a small wound was seen at the junction of the upper with the middle third of the leg, nearly in the middle of the calf, but to the inner side of the mesial line. From this, blood, both red and dark-coloured, flowed freely. The wound would not admit the finger, but a director introduced, passed through the calf in a direction forwards and upwards, to a depth of $2\frac{1}{2}$ or 3 inches. From the situation and course of the wound, and the quantity of scarlet blood flowing from it, there could be little doubt that the posterior tibial artery was wounded, and I determined to cut down upon it at once, for the purpose of securing both ends.

* On the Arteries, 4th edition, page 405.

I was so fortunate as to have the assistance of Mr. De Morgan and Mr. Lonsdale, who were upon the spot. The patient was placed on his face, yet inclining to the right side, so as to allow the right thigh to be drawn up a little on the pelvis, and the right leg, which rested on its fore and outer surface, to be flexed slightly on the thigh. Taking the wound made by the chisel as a centre, an incision six inches and a half in length was made through the integument, and this was carried by a succession of strokes through the muscles of the calf, so as to expose the deep fascia of the leg. In it was felt, rather than seen, an opening, from which blood escaped so copiously as to obscure every thing. This hæmorrhage was chiefly venous, the arterial being checked by a tourniquet placed on the thigh, which was now, however, removed, on the supposition that it might increase the venous hæmorrhage. But this did not seem to have been the case, as the dark-coloured blood flowed as before. Finding by pressure of the lower angle of the wound, that the bleeding was considerably lessened, a compress of lint was introduced here, and retained by my dresser's finger, during the subsequent part of the operation. The ligature of two muscular arterial branches was thus facilitated, but venous blood still welled in such quantity from the opening in the fascia, as to preclude all attempts to discover its source, or that of the arterial coming from the same place. The wound in the fascia was, therefore, enlarged by the probe-pointed bistoury to the extent of two inches, and, ultimately, after a deal of trouble and considerable loss of blood, by making pressure with the ends of the handles of scalpels on the various points whence this issued, it was ascertained that, besides the wound of the posterior tibial artery, the venæ comites were both divided, one completely, the other nearly so. From the lower end of the former vein the bleeding proceeded, which was held in check by the dresser's finger. To stop that from the latter, an aneurism-needle was carried under it, and a ligature applied to each end of it; the division of the vein was then completed, in order to facilitate the exposure of the artery.

The upper end of the first-mentioned vein still bled from time to time, when the patient cried or struggled, which he did, from pain and cramp, whenever much, and especially sudden, pressure was made on the divided muscles of the calf. But this did not prevent the posterior tibial artery being now seen, from the side of which scarlet blood occasionally issued in a stream. The aperture in it was small, and could not be readily made out; the vessel was, therefore, detached a little from the neighbouring parts, and two ligatures being carried round it, both were tied, one as high up, the other as low down, as the vessel was separated from its adhesions. The tightening of the first or upper ligature did not arrest the hæmorrhage, which only ceased when the lower was tied.

To allow the sides of the wound to be approximated and dressed, Mr. Barrett's finger was now withdrawn, and the compress of lint removed, but the blood again poured out so copiously, that I at first thought of putting a ligature on the end of the divided vein. But, owing to its deep situation under the fascia, and to its being firmly braced down by numerous small veins entering it laterally, this could not be accomplished without enlarging the opening in the deep fascia and the wound generally downwards. A compress was, therefore, re-introduced, and the house-surgeon directed to maintain pressure thereon for some time. This he did for three-quarters of an hour, when the finger was withdrawn, leaving the lint *in situ*. From the presence of this, no attempt was at first made to unite the wound in the integuments by stitches or strapping. Water-dressing simply was applied. The febrile disturbance which ensued was inconsiderable. On the fourth day, the compress of lint, loosened by suppuration, was removed. On the 8th day the ligature from the lower part of the artery, on the 9th that from the upper, came away. During the night of the 11th the patient, who stated he had been dreaming, was awoke by sharp pain in the leg, and the sensation of something trickling. The house-surgeon being called, found the wound at its lower part filled with coagulum, and blood of a scarlet colour flow-

ing in small quantity by the side of it. Finding that the pressure of a tourniquet on the femoral artery did not arrest this, Mr. Batley turned out the coagula from the wound, and introduced a compress of lint to the bottom of it (at its lower angle), and over this another, in which he made pressure for an hour. The hæmorrhage was hereby stopped, and it did not recur. In three days the plugs of lint were withdrawn, and the case subsequently proceeded uninterruptedly to a favourable termination.

In this instance the incisions for securing the artery were wholly within the limits of the calf. It has been stated that the external measured $6\frac{1}{2}$ inches in length, its lower end terminating $7\frac{1}{2}$ inches above the inner ankle. The width of the wound, for some time after the operation, was very considerable from the bulging of the muscles, and no attempt having been at first made to bring together the edges of divided integument. It was dreaded, that besides being slow of forming, the cicatrix would be very broad, and perhaps attended with some weakness of the limb; but in less than two months the parts had completely healed, with a cicatrix not more than $\frac{1}{2}$ or $\frac{3}{4}$ inch broad. For some time this was tender under exercise, but for several months (and I have seen Canacott this day) the limb has been, and is, as efficient as the other.

I have given the preceding details at length, at the risk of being considered tedious, in order that a just estimate of the difficulties of the operation may be formed. These were dependent on the depth of the wound,—the pain and cramp on pressure of the divided muscles,—and the venous hæmorrhage; all of these contributed to render the operation tedious, the influence of the first-mentioned circumstance, however, being the least, that of the last, the venous hæmorrhage, the greatest. The disadvantage arising from the depth of the wound, a depth increased by the muscles of the calf leaving their beds, and bulging as soon as the superficial fascia is divided, are best met by making the external and muscular incisions free, and by doing that which was done in the pre-

sent case—enlarging without reserve the opening in the deep fascia; a proceeding which greatly facilitates the discovery of the bleeding vessels.

The pain and spasm occasioned by pressure, especially sudden pressure, of the divided muscles, would, probably, be less felt, if broad retractors were employed to keep the sides of the wound apart, and these gently but steadily applied.

But the most troublesome circumstance of all was the venous hæmorrhage, a source of difficulty and delay which is not even alluded to by those who have described this operation, and yet one which in recent wounds of the posterior tibial artery must almost invariably be present, so close are the veins to the artery.

Hæmorrhage from the venæ comites is troublesome in comparison to venous hæmorrhage elsewhere, from a dense resisting fascia being extended tensely over the veins of the leg, which shields them from external pressure, so that bleeding from their divided ends cannot be stopped except by pressure directly applied, i. e. under the fascia, or by ligature.

The difficulty arising from the extravasation and impaction of blood in the cellular tissue, around the artery, and in the limb generally, was not experienced in this case, owing to the operation having been promptly performed. Where time has been lost in trying the effect of pressure on the part, assisted perhaps by that of a tourniquet on the artery higher up, which, however, can only be partial or temporary, accumulation of blood in the cellular tissue around the wounded vessel must ensue, and add greatly to the difficulty of finding it.

Taking all circumstances into consideration, it must be allowed that the operation of cutting down upon the posterior tibial artery when wounded under the calf, and tying it, is an operation severe to the patient, and troublesome to the surgeon, requiring both time and patience on his part. On the other hand, when we consider that the object of this operation is to save limb and life; that by adopting it we take the most likely method of attaining these objects, by putting in

practice the most certain means of arresting arterial hæmorrhage; that upon the evidence afforded by this case, no danger arises from the mere size of the wound, and no permanent detriment from the extensive division of the muscles,—I think it must be conceded, until experience shows the contrary, that this is the proceeding which ought to be adopted in wounds of this artery high up.

That it is an operation which ought to be done as soon after the receipt of the injury as possible, will appear very evident, but it is not one which should be undertaken inconsiderately. It requires good light, and intelligent assistants. The case which has been described occurred in the day time, and from what was then experienced, I am disposed to think that it would not have been successfully performed by artificial light, or at least with greatly increased difficulty. Four assistants were required; one to compress the femoral artery, one to separate the sides of the wound, one to tie the ligatures and to press on the mouths of the bleeding veins at the bottom of the wound till they were secured, and one for the sponge.

That in this instance secondary hæmorrhage took place, is no valid objection to the operation. This is an accidental circumstance, which will occasionally happen whenever and wherever an artery is tied. This secondary hæmorrhage, it will be recollected, came from the lower end of the vessel. The presence of the compress of lint left in the wound at this part, may have had some connection, as a source of irritation, with the occurrence of the bleeding; but a sudden motion of the limb, during the patient's dream, would account more plausibly for the pain he felt, and the hæmorrhage which followed.

The importance of immediate interference in wounds of the posterior tibial artery under the calf have been already adverted to, and cannot be too strongly impressed upon the practitioner. The consequences of doubt as to the real nature of the inquiry, and the effects of extravasation of blood going on internally, are well shown in the following

case, the particulars of which have been communicated to me by Mr. Lawrence, under whose care the case did not come until several days after the accident.

"A young man, a carpenter, was admitted into St. Bartholomew's Hospital on the 26th September 1826, having wounded his leg with a pointed iron tool. It had entered a little above the middle of the leg, about an inch behind the edge of the tibia, and penetrated to an uncertain depth. Profuse bleeding followed, which had ceased when he reached the hospital. A surgeon who saw him at the moment, said that he had wounded a large artery, and that he would lose his limb or his life. The limb slowly swelled, becoming at the same time excessively tense, hot, and painful. The glands in the groin swelled, and feverish disturbance ensued. He was bled from the arm, and leeches were applied six times.

"October 14th.—The wound was quite healed. In consequence of the great swelling and tension, pain, fever, and want of rest, an incision was made above the wound, where there was a little softness to the feel, to the depth of an inch and a half. Nothing escaped but a few drops of blood—great relief of the tension and pain followed.

"23rd.—Free hæmorrhage. On enlarging the wound, the finger went into a large cavity, of which the termination could not be felt.

"26th.—There have been small bleedings. To-day, free arterial hæmorrhage came on while Mr. Lawrence was at the hospital.

"It was now obvious that an important artery must have been wounded, and it was a question whether to cut down and find the bleeding vessel, or to amputate. The swollen state of the limb, and the reduced condition of the patient, forbad the former. The mere removal to the operating theatre made him so faint, that it was necessary to wait and give wine to restore circulation.

"Amputation was performed, and the patient recovered. A large cavity, extending from the back of the knee down to the heel, and from side to side of the limb, separated the

muscles of the calf from those on the tibia and fibula. It contained a large mass of recent coagulum, and a pint of reddish fluid, being apparently a mixture of blood and matter. This cavity was inflamed, and partly covered by lymph, partly by fibrine. After removing the coagula, a portion remained behind, adhering to the tibia. On pulling this away, it was found firm, and had a cavity in its basis as large as a hazelnut; corresponding to this cavity, there was a wound of the posterior tibial artery and vein, both being cut half across. The wound in the artery was oval, and without any coagulum." *

In conclusion, I venture to add my opinion, that when the posterior tibial artery requires to be tied high up, on account

* With the above case, Mr. Lawrence sent me a short account of another, in which, as he states, "the patient had a narrow escape from loss of his limb, under a mistaken notion of an artery having been wounded." Although not directly bearing upon the present question, its singularity and importance induce me to give it a place here.

Henry Connell, ætat. 45, admitted January 8, 1827. Ten years ago he had a tooth extracted, profuse hæmorrhage followed, and lasted two days and nights. A fortnight before admission he fell over some stumps of trees into a ditch, striking the front of his leg violently against some hard substance. In the evening the leg became hard and painful, and then gradually swelled, with redness and tension. He was bled, purged, and cold lotion applied.

At the time of admission the leg was swelled from the toes to the knee, exceedingly tense, bright red and shining, and acutely painful. Deep-seated fluctuation towards the upper and outer part. Health unaffected. The house-surgeon made an incision, and viij oz. of blood, partly fluid, partly coagulated, flowed out, with great relief.

9th.—Hæmorrhage in the night to a considerable extent, so that it was necessary to apply the tourniquet. Pulse 60, and weak. Amputation was advised by Mr. Lawrence and Mr. Earle, on the supposition of an artery having been wounded. The patient would not consent. Slight bleeding during the evening.

10th.—Tourniquet removed yesterday. Hæmorrhage in the night to some ounces. Mr. Lawrence examined the parts minutely to-day, first enlarging the wound made by the house-surgeon. The blood was found effused externally to the muscles. The opening was extended down to the heel and up to the ham, and two pounds of coagulated blood readily cleared away. No bleeding orifice could be discovered. The edges were slightly

of aneurism lower down, the easiest mode of reaching it will be by cutting directly through the muscles of the calf, instead of by incision at the edge of the tibia.

approximated, and wet cloths applied. About three pounds of arterial blood flowed in the evening from numerous minute arterial orifices.

11th.—Has slept well. More bleeding from orifices, which could not be found.

The loss of blood weakened the patient greatly, but the bleeding did not recur. The surface granulated, and the wound healed.

AN ACCOUNT OF A CASE

IN WHICH THE

CORPUS CALLOSUM, FORNIX, AND SEPTUM LUCIDUM,

WERE IMPERFECTLY FORMED.

By JAMES PAGET, F.R.C.S.,

WARDEN OF THE COLLEGE,

AND LECTURER ON PHYSIOLOGY AT ST. BARTHOLOMEW'S HOSPITAL.

Received March 2nd—Read March 10th, 1846.

The Brain, of which the description is now offered to the Society, was found by Dr. Ormerod, in a girl 21 years old, who died in St. Bartholomew's Hospital with pericarditis, and who had presented, while under observation there, nothing remarkable in the condition of her mind. I am indebted to Dr. Ormerod, both for the opportunity of publishing the case and for much assistance in collecting the evidence relating to it.

At the first examination of the head, nothing peculiar was observed in the form or texture of the skull. The dura mater was rather more than usually adherent to the upper surface of the brain, the Pacchionian glands were numerous, and the anterior part of the falx was deficient. The inner surfaces of the cerebral hemispheres were connected by pia mater in every part but one, where, in the middle line, and just above the great transverse fissure, there appeared a round aperture about one-fifth of an inch in diameter, through which the cavity of the ventricles was seen.

In the suspicion of some unusual formation, the brain, as soon as this aperture was discovered, was carefully removed

from the skull, and the following report of its condition was drawn up:—

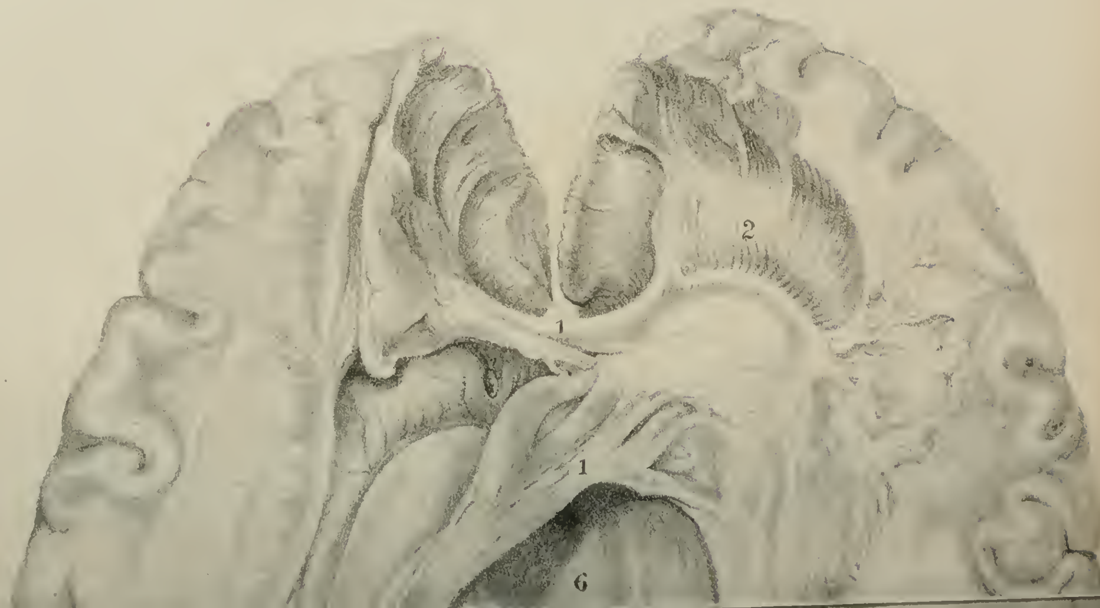
The general proportions of the brain appear normal. The antero-posterior diameter of the cerebrum is 7 inches; its width about $5\frac{1}{4}$ inches; the width of each hemisphere, measured across the anterior lobe in front of the corpus callosum, is $2\frac{1}{2}$ inches. The antero-posterior diameter of each hemisphere of the cerebellum is $2\frac{1}{2}$ inches; its whole width $3\frac{7}{8}$ inches. The convolutions of both cerebrum and cerebellum have the usual size, form, and arrangement.

On separating the remains of the cerebral hemispheres (the upper parts of which have been removed), there is visible in the ordinary position of the corpus callosum only a rudiment or a remnant of that organ.* This consists of a transverse band, measuring in the median line 1·4 inch from before backwards, having its anterior margin 1·9 inch distant from the anterior margin of the cerebral hemispheres, and the middle of its posterior margin 3·7 inches from their posterior margin.

The anterior margin of this imperfect commissure is just two lines in thickness, smoothly rounded. It is formed by a nearly cylindrical bar or cord of white nervous matter, extended from one hemisphere to the other, in a semicircular horizontal arch, with its concavity forwards. The pillars of this arch, which represents the *knee* of the corpus callosum, penetrate on each side into the substance of the cerebral hemispheres; its anterior and upper surfaces are free in the space between the hemispheres; and from its lower surface, near its posterior margin, a thin layer of grey nervous matter, the lamina cinerea, extends to the upper surface of the chiasma of the optic nerves. The posterior surface of the same arch is, on the right side, united with the rest of the corpus callosum; but, on the left side, is separated from it by a fissure from one-fourth to three-fourths of a line in width, one thin and short fasciculus alone connecting them.

The rest, i. e. the body, of the corpus callosum, forms a thin

* See Plate V. 1, 1.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fasciculated layer of white nervous substance, measuring a little more than an inch in the middle line, and gradually increasing in length as it thence proceeds towards each side and passes into the substance of the cerebral hemispheres. Its posterior margin is thicker than the rest of it, and forms a defined border, like a hem, a line and a half wide, and from half a line to a line in thickness. This border forms an arch, wider but thinner than that of the anterior border, with its concavity directed backwards, and having its pillars continued far back, thickening as they proceed towards the upper part of the convolution of the hippocampus.

In the space enclosed within, behind, and beneath the arch formed by the posterior border of the corpus callosum, there appear, after the removal of the velum, nearly the whole of the optic thalami, the middle and posterior commissures, the pineal gland and its commissure, the corpora quadrigemina, and the extremity of the superior vermiform process of the cerebellum.

After hardening the brain in alcohol, I examined some other parts of it, and, tracing as far as possible the course of the fibres in its corpus callosum, found them admitting of this description:—

The fibres, or margins of the lamellæ, in the front and upper surfaces of the anterior border of the corpus callosum, radiate, prolonging the pillars of its arch, downwards, forwards, and some downwards and backwards, into the anterior lobes of the hemispheres, in which the majority of them may be traced to the cortical substance. It appears, also, as if the whole of the fibres of this anterior border were thus continued into the lower part of the anterior lobes.

The middle, thin, and fasciculated portion, or body, of the corpus callosum is composed of flat bands of fibres, a few of which extend transversely from one hemisphere to the other; but the greater part pass with various and unsymmetrical obliquity, decussating with the transverse bands and with each other. Most of these oblique bands pass from left to right; the whole of the left side of this part of the corpus callosum being thicker than the right.

On the right side, (on which alone they were left perfect,) all the fibres of this part of the corpus callosum pass outwards, radiating, and forming the roof of the lateral ventricle. On their way, none of them pass upwards to the convolutions of the inner part of the hemisphere; but they all, opposite the outer margin of the corpus striatum, rise, and then again descend, so as to form a ridge like that formed by the fibres of a natural corpus callosum, but only half as high and half as wide, and not reaching further back than the middle of the margin of the optic thalamus. Outside the ridge, the superficial fibres which are engaged in forming its anterior half, appear to continue their course, radiating still outwards, and shortly turning upwards into the upper and outer part of the anterior lobe of the hemisphere, the part which is directly above the *island* of Reil. The fibres which are engaged in the posterior half of the ridge, and some yet further back, become entangled at its outer margin; they appear to turn rather abruptly downwards, decussating with bundles of fibres, which are proceeding from below upwards and from within outwards.

The fibres of the most posterior part of this body of the corpus callosum proceeding far backwards, are confused with those of the posterior thickened hem-like border, and perhaps with those also of the fornix; and the fibres of the three, thus mingled, divide into two portions, which completely enclose and form the walls of the posterior horn of the lateral ventricle, and which do not appear to pass further into the substance of the hemisphere; and a third portion, which proceeds in the ordinary way over and along with the convolution and tænia of the hippocampus.

On the under surface of the corpus callosum there is not, in their usual position, a trace of either the septum lucidum, or the middle part of the fornix. The side portions of the latter organ are closely attached to the whole length of the body of the corpus callosum, and are natural in size and arrangement. The anterior and posterior commissures, and the pillars of the fornix, present no deviation from what is

usual; but the middle, or soft commissure, is very large. It measures six-tenths of an inch from before backwards, and at its posterior border coalesces with the nates below the orifice of the aquæductus Sylvii. It appears also rather thicker than is usual.*

In no other part of the brain could I discern anything uncommon in either size or structure.

In the hope of obtaining some guidance in the obscure physiology of the corpus callosum, I made careful inquiries into all that concerned this patient's mind. I procured evidence from her father, step-mother, master, and near neighbour, who all agreed on all essential points.

Her father is a workman in a colour manufactory, and has the best testimonial of the good condition of his mind, in that he has been twenty-five years in the same service. Her mother, who has been dead eleven years, presented nothing remarkable in the state of her mind, till about twelve years before her death, and two years before the birth of this girl, when, without any known cause, she became melancholy, fearful, and insane on matters connected with religion. Her insanity was aggravated while she was pregnant with her third child; and during her pregnancy she twice attempted to commit suicide by jumping from a window. Her melancholy was again aggravated in each of three following preg-

* The middle commissure is peculiarly liable to variations of size, but its dimensions in this case were so great that they must excite a suspicion whether, notwithstanding the difference of their apparent structure, it may not have compensated in a small degree for the deficiency of the corpus callosum. Duplicity of the middle commissure is, I believe, so rare, that I may be allowed to take this opportunity of mentioning a case which has been lately observed by my brother, Dr. Paget, in an unusually intelligent agricultural labourer, 22 years old, who died under his care, with ulceration of the cervical vertebræ, in Addenbrooke's Hospital, at Cambridge. The two commissures lay one above the other, a space intervening of sufficient size to admit a large probe between them. "Both consisted of thin sheets of grey cerebral substance, and presented lunated edges before and behind. The lower one was above half an inch long; the upper one less than a quarter of an inch. The latter was situated exactly above the middle of the former." All the rest of the brain was naturally formed.

nancies; and her husband clearly remembers that it was so while she was pregnant with this girl. She made no more attempts to commit suicide, but it was at this time necessary to have nurses constantly watching her.

The girl herself was not remarkable for any excellence or great defect of mind. She was light-hearted, happy-tempered, heedless, and very girlish in her manners. Her moral character was unimpeached, even by her step-mother, who certainly did not err by judging too kindly of her; and her master, a respectable master-printer, thought her so trustworthy, that for two years he daily left his house in her sole charge. She habitually attended church, and had no indications of the insanity under which her mother laboured.

She was educated for six or seven years in the Islington School of Industry, where she learned to read very well; but after she left the school, she always read in a headlong way, very fast, sometimes missing words, and not staying to correct herself. She showed great facility in learning by rote; she could thus learn twenty verses of the Bible in about half an hour. She had a good verbal memory, and as long as she was in health, used to be constantly singing hymns and scraps of songs which she had learned in childhood. She was taught in writing, but she acquired the art so imperfectly, that she could scarcely do more than write her own name. She had not a much better knowledge of arithmetic, and would make mistakes in reckoning her wages, or in receiving change of money. She was dexterous, but not accomplished, in all household work.

Her heedlessness was remarkable in her dress; she was almost indifferent to what she wore, and in her own person was of uncleanly habits. She showed almost as little regard for money, and would make bad bargains many times in the same kind of transactions. She had a singular way of speaking, addressing and answering her equals always, and her superiors sometimes, in a sharp, abrupt, off-hand manner, with seeming, though not intended, rudeness; and in this she persisted, though often reproved for it.

But, from all that I could hear, I could not find otherwise than that this girl's mind was one of the least remarkable kind. Her only peculiarity was vivacity, and a want of caution, showing themselves in an habitual rapidity of action and want of forethought, deliberation and attention. Certainly she could not be regarded as unusually deficient in either moral goodness or intellectual power; for if we consider her scanty school instruction, the neglect of teaching which she must have suffered in her early years, while her mother was insane, and her natural heedlessness, we must admit that she acquired at least as much knowledge as the average of persons in the like case would.

Before discussing the many questions which this case suggests, I will state the chief facts of the other recorded instances in which the corpus callosum was defective, without any other serious wrong condition of the brain.* These instances are very few; and when it is sometimes said that they are not a few, I suspect it is because one of them, that

* The cases which are excluded on the ground of their being complicated, and therefore uninstructive on the questions here considered, are comparatively numerous. Such are the cases recorded by G. Battista, (Storia del Mostro di due Corpi. Campana: 1748. 8vo.) of a child, quite senseless and motionless, which had no corpus callosum, and, it is said, scarcely a trace of pons, or medulla oblongata; that by Sandifort, (Museum Anatomicum Acad. Lugduno-Batavæ, t. iv. p. 86, tab. cxc, cxci, Lugd.-Batav. 1835. folio,) of an idiot, 20 years old, who had an exceedingly small and anteriorly narrow brain, with a corpus callosum like that of this girl; the case of James Cardinal, recorded by Dr. Bright, (Reports of Medical Cases, vol. ii. p. 431,) and by Dr. Spurzheim, in his "Anatomy of the Brain," and other works, in whom the corpus callosum, after exceeding distension in chronic hydrocephalus, gave way, but it is not known when or with what result. Notices of other cases of deficiency of these commissures, associated with still greater malformations of the rest of the brain, such as hydrocephalic hernia of the hemispheres, cyclopia, anencephalia, &c., may be found in the works of Isidore Geoffroy St. Hilaire (Histoire des Anomalies, t. ii. Paris: 1836), Vrolik (Handboek der Ziektekundige Ontleedkunde, D. i. p. 528, &c. Amsterdam: 1840), and Rokitansky (Handb. der Pathologischen Anatomie, B. ii. p. 760, &c. Wien, 1844). Treviranus (Biologie, B. vi. p. 155), and Tiedemann (Anatomie der kopflosen Missgeburten), may also be referred to. Since this paper was read, a case has been published by Dr. Ogier Ward, in the Medical Gazette, March 27, 1846.

by Reil, has been so often quoted, that it has seemed to be many different cases.

The first case that I can find is recorded by Reil.* A woman about 30 years old, who was otherwise healthy, but was of dull intellect, yet could go on errands from the village where she lived, to the town, and carry common messages, suddenly fell, and died apoplectic. On opening the head, it was found that the ventricles were moderately full of water, and that the corpus callosum was divided longitudinally in the middle, or, rather, that its middle and free part was in its whole length deficient. The optic thalami lay exposed, and the two halves of the cerebrum were held together only by the commissure of the optic nerves, the anterior commissure, the isthmus of the crura cerebri in front of the pons, and the corpora quadrigemina. Anteriorly, the whole of the knee and of the crura of the corpus callosum, as well as the septum which lies within the knee, were wanting. The inner surfaces of the anterior cerebral lobes were completely separate down to the anterior and middle commissures; and the parts of them in which the knee and the beak of the corpus callosum should have been inserted, were covered with such convolutions as commonly the surface of the brain is covered with. The middle and posterior part of the corpus callosum, and its appended posterior border, were also absent.

The fornix arose as usual from the optic thalami, formed the corpora mammillaria, ascended from them behind the anterior commissure, coalesced on both sides with that part of the roof of the cerebral ventricles which runs just under the longitudinal convolutions, and formed with it a smooth and rounded edge. It then curved round the posterior part of the optic thalamus, entered the descending horn of the lateral ventricle, and adapted itself therein in the usual manner.

A second case is recorded by Mr. Solly;† and the speci-

* Reil and Autenrieth's Archiv für die Physiologie, 1812. Vol. xi. p. 341.

† The Human Brain, p. 433. London: 1826. 8vo.

men which he describes is preserved in the Museum of St. Thomas's Hospital, where I was favoured with permission to examine it and the account of the patient which is inserted in the Case-book.

The patient was 17 years old, but did not appear more than 15. He died seven days after a fall, in which the base of his skull was fractured; and it is unfortunate that we have not the advantage of Mr. Solly's own observations concerning the state of his mind, since he was almost totally insensible from the time of the injury to that of death. The account given by his mother, who was not an intelligent person, was that she considered he was never right from his birth, and that, in consequence of a difficult labour, as she supposed, he had always been of weak intellect. It had always appeared difficult to him to maintain the erect posture, and he used to stumble and roll about. He had been from infancy unable to hold up his head, and generally appeared drowsy. He was fond of reading, and religious books were his greatest favourites. He was childish in his amusements, very good-tempered, and willing to do all that was required of him. He sometimes talked pretty rationally, but generally, to use his mother's expression, he "was boobyfied." It is said that he had no power of reviving or comparing impressions on his mind; but this is sufficiently disproved by the fact that he could read, and was fond of a particular class of books.

On separating the cerebral hemispheres, parts of which were deeply injured by the fracture of the skull, there was seen in the place of the corpus callosum, a pale semitransparent membranous cyst attached to the left hemisphere, forming part of the roof of the left lateral ventricle, and protruding into the space between the hemispheres. The cyst was formed of thin membrane, and had numerous small vessels ramifying on its inner surface: it measured two inches in length, and one inch in width, and contained about an ounce of limpid fluid.

The corpus callosum is wholly absent; and the third ven-

tricle, which is exposed in the preparation, was covered by only a thin membrane, probably the velum. The middle part of the fornix is also absent. Its right pillars and lateral portion appear to be perfect; the outer thin free border lying in its usual position, over the optic thalamus: its inner border is united to the inner wall of the lateral ventricle, so that there could have been, I think, no opening into the right ventricle above the fornix. A part of the left posterior pillar of the fornix also appears, but is diminutive; it is similarly attached to the inner wall of the left ventricle: the anterior and chief part of this wall is occupied by the cyst, which conceals, and, possibly, has destroyed some of, the rest of the fornix.

Both the lateral ventricles are very much enlarged, and each contained about four ounces of fluid. The third ventricle also is large, and the middle commissure appears both wide and thick.

The patient in a third case related by Mr. Chatto,* was a child who died when a year old. During the last nine months of its life, it was subject to violent convulsive fits, recurring several times daily; but so little interfering with its general health, that, till within a few weeks of its death, it grew and appeared quite well. In all its life it "manifested no sign whatever of recognising persons or objects."

In examining the brain after death, a considerable quantity of fluid escaped when the dura mater was cut through, flowing, apparently, from between the hemispheres. On separating the hemispheres, the cavities of the lateral ventricles were at once exposed, the corpus callosum, septum, and middle part of the fornix being absent, with the exception of two narrow slips of the corpus callosum, a few lines in breadth, which were extended between the anterior portions of the hemispheres. Just anterior to the corpora quadrigemina, lying in a cavity large enough to contain the tip of the little finger, was "an hydatid, about the size of a small hazel-nut, having much smaller ones adhering to it, and filled with a

* London Medical Gazette, Jan. 10, 1845.

gelatinous fluid." The optic nerves, and the tubercula quadrigemina, were remarkably small. A small quantity of fluid was found in the ventricles. The cerebral substance was very firm.

I can find no cases besides these in which the history of persons suffering from almost uncomplicated deficiency of the corpus callosum is recorded. And of examples without histories, two only appear; namely, one mentioned by Meckel,* in an adult woman, the rest of whose brain was in a natural state, except in that the lateral ventricles were rather large: and another referred to by M. Longet,† as seen by M. Förg, in an adult male epileptic.

But, though these cases be few, they afford good evidence on some questions in the anatomy, the development, and the functions of the corpus callosum. And first, respecting its anatomy. In the brain which I have described, and of which an accurate drawing, by Mr. Delamotte, the Librarian of St. Bartholomew's Hospital, accompanies this paper (see Plate V.), the thinness of the corpus callosum, and its fasciculate character, afford a rare opportunity of perceiving the arrangement of its fibres. Of these fibres, a considerable proportion pass across the space between the hemispheres, with a degree of obliquity which is not implied either in the name of "great transverse commissure," or in the description which is usually given of this organ. For, of all the writers to whose works I have referred, Burdach ‡ alone speaks of any of the fibres passing otherwise than transversely in the free part of the corpus callosum, and he says, only, that "many fibres from an anterior part of one hemi-

* Pathologische Anatomie, B. i. p. 301.

† Anatomie et Physiologie du Système Nerveux, t. i. p. 536. M. Longet, probably quoting from Meckel (Handb. der menschl. Anatomie, B. iii. p. 302), refers to what he supposes to be a similar case in Wenzel. But the only case to which he can allude is one of a three months' fœtus (De penitiori structura cerebri, fol., p. 302), in which the corpus callosum was, perhaps, not yet formed, or in which it may have been broken in the examination.

‡ Vom Baue und Leben des Gehirns, B. ii. p. 143.

sphere go to a somewhat more posteriorly situated part of the other." But in this specimen, many fasciculi of fibres proceed from the anterior quite to the posterior part of the body of the corpus callosum; and if these be, as I believe, representatives of similar fibres in the healthy corpus callosum (for the deficiency here existing is not of a kind to generate an unnatural obliquity of fibres), they exhibit a fact of no small importance; for, according to the usual descriptions of this and the other commissures, there is an ample commissural connection between several parts of each hemisphere, and between the corresponding similar parts of the two hemispheres, but none between the anterior parts of one hemisphere and the posterior parts of the other. Such a connection may be formed by fibres like those which are here shown; although I have often failed in attempts to trace fibres as oblique as these in the healthy corpus callosum. In such attempts, as one separates the vertical lamellæ in transverse cleavings of the organ, proceeding from its outer side towards the median line, comparatively few fibres are broken; but at the median line there is such an interlacement of the fibres of the successive lamellæ, that the cleavage cannot be continued till many of them are torn across. I have been unable to trace, for even a short distance, the further course of the fibres which are thus broken; but it is not improbable that here, in or near the median line, a small proportion of the fibres of the corpus callosum deviate from the transverse into an oblique or longitudinal course. Something of the kind is indicated in this specimen, in which some of the largest fasciculi go transversely from the outer side to the middle of the corpus callosum, and then assume the oblique direction. These are all in the body of the corpus callosum: the fibres, in its anterior and posterior borders, appear all to pass transversely, as if uniting corresponding parts in the opposite hemispheres.

Secondly,—With regard to the normal development of the parts which are in these cases defective, there does not in them appear any help towards the decision of the question

how, and from what parts, the corpus callosum is first formed.* Yet some conclusions may be drawn from these cases.

1. In the first case, the fibres of a corpus callosum, of which the development was probably arrested (according to the description by Tiedemann†) in or before the sixth month of fœtal life, are traceable to all the regions into which those of the perfect corpus callosum extend. Defective as they are in number, they appear normal in their plan. We may, therefore, believe that in the early fœtus, the corpus callosum, though it bears a less proportion to the size of the cerebral hemispheres than it does in after-life, yet from the first gathers its fibres from all its usual sources.

2. The examination of these defects confirms what we might deduce also from comparative anatomy, namely, that the corpus callosum is that part of the brain, the development of which is last of all attained. For the corpus callosum has been often absent or imperfect in cases of defect of the cerebral hemispheres: but it has also sometimes been absent when nearly every other part of the brain was perfect. The former cases confirm the rule derived from comparative anatomy, that, in the brains of placental mammalia, the development of the corpus callosum is commensurate with that of the extra-ventricular masses of the cerebral hemispheres. The latter cases show that there is no part of the brain, the development of which is dependent on that of the corpus callosum. Probably not even the middle part of the fornix is thus dependent, for we may explain its coincident absence in every recorded case of abnormal absence of the corpus callosum, on the supposition that the same diseases hindered at once the development of both: while in favour of its independence, are the facts discovered by Professor Owen,‡ that,

* See on this question Bischoff's Entwickelungsgeschichte; in v. Soemmering. Vom Baue des menschl. Körpers; Leipzig, 1842, B. vii. p. 176.

† Anatomie und Bildungsgeschichte des Gehirns im Fœtus. Nürnberg, 1816. 4to. p. 155.

‡ On the Structure of the Brain in Marsupial Animals; in the Philosophical Transactions, 1837, p. 87.

in the marsupialia, the middle transverse portion of the fornix exists without a corpus callosum, and that, in the whole mammalian series, the corpus callosum and fornix are developed commensurately with two distinct parts, namely, the corpus callosum with the extra-ventricular masses of the cerebral hemispheres, and the fornix with the hippocampi and their tæniæ. Even the septum lucidum, though its position and apparent extent in man may be determined by the relative positions of the corpus callosum and fornix, yet probably is dependent for its development on the latter alone. For the analogues of the septum lucidum are found in the marsupialia, and in birds, without any corpus callosum, in the laminæ of medullary substance which extend from the superior and internal border of each hippocampus to the overlapping inferior and internal border of the hemisphere: and in Reil's and Solly's cases, the bond of connection between each of the lateral halves of the fornix and the hemisphere, by which bond the internal and superior wall of the lateral ventricle is completed, must be regarded as the analogue of one layer of the septum lucidum; the two layers, which should have between them only the narrow cavity of the fifth ventricle, being, in all instances of complete absence of the corpus callosum, placed wide apart, and attached directly to the hemispheres themselves. In the case which I have here described, the analogues of the septum lucidum are in an intermediate position, corresponding to the imperfection, but not total absence, of the corpus callosum; for they connect the lateral halves of the fornix, not to the margins of the hemispheres, but to the under surface of the corpus callosum; yet they are very far asunder.

Thirdly,—I beg to offer some considerations on these cases, in the relation which they bear to questions concerning the physiology of the corpus callosum.

They prove, as the facts of comparative anatomy also do, that a corpus callosum is not necessary for the mental reception of sensations, or for the ordinary exercise of the will upon the muscles, or for the natural movements of any inter-

nal organs, or for due nutrition or secretion in any part. On these points, the cases recorded by Reil and myself afford unexceptionable evidence, and the defective voluntary movements in Mr. Solly's case may be fairly ascribed to the existence of the large cyst in the left cerebral hemisphere, and to other adjacent morbid conditions, probably coincident with it. The apparent opposition of Mr. Chatto's case may be similarly explained. The cases, therefore, prove that, in regard to sensation and voluntary motion, that is true in the instance of man, which has been proved for lower animals, by the experiments of many physiologists, from Lorry* to Valentin,† and Longet,‡ who have found that neither pain nor convulsion is excited by irritation of the corpus callosum, and that, after its complete longitudinal division, sensation and voluntary motion are retained. And, certainly, the plain negative results of these cases prove more than such experiments can; for experiments on animals cannot prove that any part of the human brain is not, in direct proportion to its greater development, placed in a more close connection with the lower functions of the nervous centres. They are also better adapted than such experiments are, to disprove the contrary conclusion, drawn from certain instances of disease ;§ in which instances we may be sure that the insensibility, convulsions, and other like symptoms, supposed to be dependent on the disease of the corpus callosum, were really due to the coincident disturbance of some other part of the brain.

Again, these cases are opposed to the apparent results of those experiments of Valentin‖ which led him to believe that division of the corpus callosum in rabbits produces an acceleration of the heart's action, and an increased secretion of bile, and of the fluid of the small intestines, together with

* Mem. des savants étrangers, t. iii.; quoted by Longet, l. c., t. i. p. 534.

† Ueber dis Thätigkeit des Balkens; in his Repertorium für Anatomie und Physiologie, B. vi. 1841, p. 361.

‡ Anat. et Phys. du Système Nerveux, t. i. p. 534.

§ The best collection of such cases may be found by referring to Burdach, Vom Baue und Leben des Gehirns, B. iii. p. 485.

‖ L. c. p. 359, e. s.

apathy and an obstinate and vicious temper. No condition like any of these has been observed when the corpus callosum was absent: probably, therefore, if these were really the consequences of his experiments, they depended on the damage of some other part.

We are thus compelled to seek for the office of the corpus callosum among the higher and more internal functions of the brain. But we search in intense obscurity, for the facts do not even show that its existence is necessary to the possession and average development of any of the admitted faculties of the mind.

We might hope to obtain a clue to its function in some characteristic mental distinction between the placental mammalia, in whom the corpus callosum exists, and all the other vertebrata, in whom it is totally absent. But I believe that if we take these mammalia as a class, we are not yet acquainted with any such superiority, either in the kind or number of their mental faculties, or in the apparent power of any of them, or in their mode of manifesting them, as we can ascribe to their being sole possessors of this organ.

These cases of morbid anatomy are hardly more instructive. One-sixth, or a less portion, of the corpus callosum, in the girl whose history I have related, sufficed for all the ordinary operations of the educated mind. I am aware that, in certain cases * of destruction of nervous matter, the loss of power

* Those to which I here especially allude, and which probably are most nearly analogous to deficiency of the corpus callosum, are the examples, such as are mentioned by Ollivier and others, of the spinal chord retaining an apparently unimpaired power of transmitting impressions through a small remnant of its substance. These examples occurring in diseases are confirmed by some of the experiments of Van Deen (Nadere Ontdekkingen over de Eigenschappen van het Ruggemerg. Leiden, 1839), and Volkmann (Wagner's Handworterbuch; Art. Nervenphysiologie). And an experiment which I have often made on the hearts of turtles shows something of the same. If a portion of the heart, while still irritable, be so nearly divided into two, that the halves remain connected by only a very narrow isthmus of muscular substance, and one half be mechanically irritated, the subsequent contraction, after extending through this half, will

appears to be less than that of structure: yet if the corpus callosum were really necessary to the operations of a human mind of average power and capacity, its great imperfection should, in this instance, have been marked by some evident sign.

In Mr. Solly's case of complete absence of the corpus callosum, the boy's intellect was weak, but not so weak as on the first reading of his history it may appear. For it must be considered that, in spite of bodily infirmities, which had existed from birth, and were of a kind apt to bring ridicule and neglect—with little education—and with a mother who (Mr. Solly tells me) appeared less intelligent than most hospital patients,—this boy had learned to read, and had acquired a fondness for books, and especially for religious books. In a person in his social and bodily condition, such attainment indicates, I think, the possession of nearly an average amount of mental power. Moreover, whatever mental deficiency there was in him, it cannot be, certainly, all ascribed to the absence of the corpus callosum: his brain had other defects. The permanent distension of the ventricles by fluid might not be attended by weakness of the mind;* but the large cyst over the ventricle, existing, as it probably did, from birth or infancy, and involving the middle of one half of the fornix, may have had a more evil influence. Reil's case, if it stood alone, would afford as much evidence as one case can, that the corpus cal-

extend also across the isthmus, and thence over the whole of the other portion; the few nerve-fibres in the isthmus thus serving to convey the irritation to the many in that half of the portion of heart which was not directly irritated. Such a transmission will not take place through a portion of tendon connecting two pieces of the heart.

* In the Museum of St. Bartholomew's Hospital (Series 6, No. 64), is the brain of a young man who was remarkable for cleverness and for excellence in his work as an ornamental room-painter. He was said to have had hydrocephalus in infancy, and the shape of his head confirmed this account. He died of some disease not connected with the brain, and the lateral ventricles were found each containing about three ounces of fluid, with their lining membrane thickened and granular, and adhesions of the fornix and choroid plexuses to the optic thalami.

losum is necessary to the possession of the average power of the human mind. Yet caution is necessary in concluding from it, because, though the mental defect seems to have been greater than in Mr. Solly's case, yet the apparent cerebral defect was less: some, therefore, of the greater defect must be ascribed to a structural error in the brain which was not discerned, and if a part of it was certainly due to this, more may have been. And, indeed, so long as we are unable to tell whether the structure of a brain is absolutely healthy or not, we shall have no right to ascribe to the absence of a corpus callosum a greater amount of mental deficiency than existed in Mr. Solly's case: rather, we may expect, that if a brain should be found, having really no defect, except the total absence of the corpus callosum, it will be in a person who had more mental power than the boy had, whose history Mr. Solly has recorded.

On the whole, these cases force us to think that the corpus callosum has its office as an organ for the highest operations of the mind. But of what part of the mind it is one of the ministers, and how its function is discharged, we have no evidence whatever. Its structure indicates that it is not a nervous centre, neither a source of nervous power, nor a first recipient of the influence of the mind: for it is composed wholly of nervous filaments, such as, elsewhere, have no higher office than that of conducting impressions, and are incapable of either originating, controlling, or diverting them. If, therefore, as a reasonable hypothesis, we adopt the general expression of the office of this and other commissures, that "they serve to ensure unity or harmony of action between those parts of the brain between which they are placed," we must use it as meaning, for the corpus callosum, not that it is a centre of action from which similar, and, therefore, harmonious influences proceed to each side; but that it is formed of conductors, by which a part on one side of the brain is informed (as it were) of the state of some part on the other side, and, probably, is induced into the same state. But, whatever may be meant by this and any similar forms of ex-

pression, they must be held as only hypothetical; there is no substantial evidence for their truth.

It is not a valid objection against the opinion that the corpus callosum is necessary to only the highest operations of the human mind, that a similar organ exists in nearly all mammalia, although their minds are incapable of such acts as are performed by even the poorest human intellects; for what is assumed is, that the corpus callosum is necessary to the highest offices of which the cerebral hemispheres are capable, and it may be equally necessary to those which are, relatively, the highest offices in any animal, although, absolutely, the dignity of these offices may be very different in different instances.

Many of the facts here adduced afford support to that doctrine of the brain being a double organ, to which, though often assumed or discussed, the admirable Essay of Dr. Holland* has first given clearness and determination, and to which, perhaps, more attention than his essay received, has been attracted by the vigorous writings of Dr. Wigan;† for, if it is not necessary that the two halves of the cerebrum should be connected, in order that the mind may exercise all but its highest powers, it is certainly very probable, that for all but these, each half is, by itself, a sufficient organ. But as it is not my purpose to consider the physiology of the cerebral hemispheres, I shall not dwell on this subject, already so well discussed in the works to which reference has just been made.

* On the Brain as a double organ: in his Medical Notes and Reflections, p. 151. London, 1839.

† The Duality of the Mind. London, 1844; and in the Lancet, 1843-4-5.

EXPLANATION OF PLATE V.

1, 1.—The anterior and posterior borders of the corpus callosum.

2.—The fibres of the anterior, and (3) the fibres of the posterior, part of the corpus callosum, radiating into the right cerebral hemisphere.

4.—Fibres of the corpus callosum joining those of the hippocampus.

5.—The cavity of the posterior horn of the right lateral ventricle.

6.—The soft, or middle, commissure.

7.—The left margin of the fornix exposed by opening the left lateral ventricle.

8.—The cut margin of the corpus callosum, turned aside to expose the cavity of the left lateral ventricle.

CASE

OF

ANEURISM,

PRESENTING SOME PECULIARITIES;

WITH REMARKS.

By PRESCOTT HEWETT, Esq.,

LECTURER ON ANATOMY AT ST. GEORGE'S HOSPITAL SCHOOL.

Received January 13th—Read January 27th, 1846.

G. B., ætat. 31, was admitted into St. George's Hospital, under the care of Sir Benjamin Brodie, in May 1839, with a pulsating tumour, of the size of a pullet's egg, in the left groin, about an inch below Poupart's ligament, and apparently connected with the common femoral artery. The tumour, which was soft and compressible, presented very evident pulsation and expansion, accompanied by a distinct whir. The patient stated that he had, for the first time, perceived the tumour about three weeks previous to his admission, when it was of the size of a small walnut, but that he could not assign its appearance to any cause. He complained of great pain down the leg, but particularly at the inner side of the knee; the pain was accompanied by a sensation of pins and needles in the limb. He was a carpenter by trade, and had been in the habit of lifting very heavy weights. His manner was irritable, owing, most probably, to his having drunk very hard, but his general health was, he stated, very good.

As a careful examination of the heart and large arteries did not point out any disease about these parts, Sir B. Brodie applied, on the 30th of the month, a ligature to the external iliac artery, some distance above the origin of the epigastric,

and all pulsation in the tumour ceased immediately. The operation was followed by peritonitis, which was treated with small blood-lettings, and calomel and opium. The inflammatory symptoms soon put on a typhoid character; the wound, which had partially healed, was opened, and a quantity of sanious putrid matter evacuated. Subsequently it was found necessary, on account of his previous habits, to give him wine, &c., and, under this treatment, he gradually rallied from this severe attack. With the exception of some slight ailments, he went on improving; the ligature came away, without any mischief, on the 25th day after it had been applied; the tumour in the groin became solid, and gradually decreased in size; the wound healed, and he was discharged from the hospital on the 14th of August, cured.

At the latter end of November, he was re-admitted into the hopital, on account of a return of slight pulsation and a whirring sound in the tumour, which had again slightly increased in size. He stated that, after leaving the hospital, he had returned to his work, and that everything had gone on well, until the beginning of this month, when the pulsation began to make its appearance. Sir B. Brodie ordered pressure to be tried: the patient was accordingly confined to his bed; some graduated compresses were applied over the tumour, the whole limb carefully bandaged, and a figure of 8 bandage was passed round the pelvis and the upper part of the thigh. This plan of treatment was pursued for two months, at the end of which time all pulsation and sound again disappeared, and the patient was shortly afterwards once more discharged from the hospital.

He was seen again in November 1841, when it was found that there was a slight recurrence of the pulsation; as the tumour had not, however, increased in size, no plan of treatment was adopted.

In January 1842, when seen again, the tumour was observed to have increased in size, but no pulsation whatsoever could be detected in it, even after a most careful examination.

From this period, the tumour gradually but steadily increased in size for the ensuing twelve months, during which time it grew to the size of the egg of an ostrich; its surface was somewhat irregular, and softer in some parts than in others, although the tumour itself was perfectly solid. During the whole of the time neither pulsation nor sound of any kind could be detected in the tumour, although repeated and careful examinations, both manual and stethoscopic, were made by several experienced surgeons.

In January 1843, the tumour became stationary, and some time afterwards it began to diminish; the decrease in size continued until July of the same year, when the patient died of phthisis, symptoms of which had existed for some time.

At the examination of the body, the lungs were found thickly studded with tubercles and vomicæ, in various stages of development; the cavities of the heart were somewhat dilated, and their walls were thinner than natural, but the valvular apparatus was healthy. No morbid appearance was observed in any part of the whole course of the aorta. The viscera contained in the abdominal cavity presented nothing remarkable.

The tumour, which was situated in the left groin, was lying upon the superficial femoral artery, at about a quarter of an inch below the point where this vessel comes off from the common femoral. When separated from the neighbouring parts, it was of the size of the head of a full-grown fœtus, slightly irregular on its surface, but perfectly solid throughout. Upon being cut into, it presented the characteristic layers of coagulated blood observed in aneurisms which have been cured. These coagula, which had, for the greater part, lost their colouring-matter, were disposed in very thin layers, closely packed together, and completely filling up the aneurismal sac, which was formed by the outer coat of the vessel, and remarkably thin towards its anterior part. The portion of the superficial femoral artery, about two inches, with which this aneurism was connected, was flattened, completely ob-

literated, and identified with the tumour, below which the cavity of the artery was filled with a coagulum, about an inch in length, somewhat smaller than the vessel, and adherent to it at its upper part only; the remaining part of this vessel presented a natural appearance. The whole of the common femoral was dilated to the size of the common iliac, and irregular on its surface, the irregularity depending upon some smaller dilatations superadded to the general dilatation, which extended up to the external iliac, at the point of the giving off of the epigastric and circumflex arteries. The internal surface of this dilated vessel was covered by thin layers of coagulated fibrine, which, beginning a little below the origin of the epigastric, were continued downwards into the upper parts of the superficial and deep femoral arteries. In the superficial femoral, these coagula completely blocked up the cavity of the artery; but in the deep and in the common femoral, they merely formed a lining to these vessels, a large and distinct channel being still left for the passage of the blood. This channel was, for the greater part, perfectly smooth, and lined by a membrane, of new formation, presenting all the characters of the serous coat of the artery, for which it might easily have been mistaken. Both the membrane and the coagula were, however, with a little care, detached from the internal coat of the artery, which did not appear to be diseased. These coagula did not pass further than half an inch down the deep femoral; below this, the coats of the artery presented a perfectly healthy aspect.

The external iliac artery, from a little above the origin of the epigastric and circumflex, to within a quarter of an inch of the common iliac, was completely obliterated, and reduced to the size of a small quill; the point at which the ligature had been applied was marked by a constriction, situated about an inch above the origin of the epigastric. The various branches given off from the external iliac, and from the common and deep femoral arteries, were much larger than natural; but as I was not allowed to make a minute dissection of these vessels, I cannot enter into any detail concerning this

point of the subject. No abnormal distribution of vessels was observed either about the aneurismal sac, or in the large arteries of this region.

Remarks.

Several cases in which pulsation has re-appeared in an aneurismal tumour after the application of a ligature to the main trunk of the affected artery have already been recorded. The case just related differs, however, from most of those on record, in the long intervals which elapsed between the two periods, when the pulsation recurred; intervals during which the tumour presented all the appearances of being cured.

No abnormal distribution of the arteries having been found, the re-appearance of the pulsation is to be explained by the situation of the aneurismal tumour, which, when once the collateral branches were sufficiently dilated, became affected by the large current of blood brought into its immediate neighbourhood,—a current of blood sufficient to overcome, for a time, the efforts made by Nature to establish a cure, which she ultimately accomplished.

The great increase in size which this aneurism presented, even after all pulsation and all sound had ceased in it, is a fact worthy of the attention of all practical surgeons. By this increase in size, and the other circumstances accompanying this aneurism, several experienced surgeons were led to the supposition that the tumour was of a malignant character, and supplied with large arteries, the growth of which had been checked for a time by the obliteration of the external iliac artery. This case, which, for so long a period, was accompanied by such unusual circumstances, acquires an increased degree of interest, when it is compared with some of the cases of pulsating tumours, to which our attention has been so lately directed by Mr. Stanley, in the last volume of the Transactions of this Society.

With reference to the pathology of aneurisms, the appearances observed about the common femoral present two points

of interest. It has been stated that the coagula lining this dilated vessel were covered over by a thin, delicate membrane, presenting to the naked eye all the characters of the serous coat of an artery.

The cavity of a vessel thus dilated may be restored nearly to its natural diameter by the deposition of thin layers of coagula in the dilated portion; the free surface of these coagula being subsequently covered by a membrane, of new formation, of a serous aspect, and perfectly adapted to the true serous coat of the artery, the disease will at first appear to consist, not in a dilatation of the vessel, but merely in a thickening of its coats with a deposition between them. Lastly, the appearances observed in this dilated vessel may also, under certain circumstances, be readily mistaken for what is termed a dissecting aneurism. If the thin layers of coagula and the false membrane should not be connected with the internal coat of the artery in the whole of their circumference, or if the coagula should be partially detached from each other, a channel will be left through which the blood may pass, and thus the most prominent appearances of a dissecting aneurism will exist; the serous membrane, of new formation, representing the internal coat of the artery, and the coagula, its middle coat, diseased and thickened.

CASE

OF

CYANOSIS

OF FORTY YEARS' STANDING,

DEPENDING UPON CONGENITAL OBSTRUCTION IN THE PULMONARY ARTERY, AND PATULOUS FORAMEN OVALE.

By ROBERT J. SPITTA, M.B., Lond.,

HOUSE-SURGEON TO ST. GEORGE'S HOSPITAL.

Communicated by PRESCOTT HEWETT, Esq.

Received November 28th, 1845—Read January 27th, 1846.

In recording the present case, I propose to adopt the following order:—1st, To describe the attack which immediately caused death. 2nd, To detail the history from birth. 3rd, To give the *post-mortem* examination. And, lastly, To draw four very simple pathological deductions.

1. *Attack causing death.*—On March 3rd, 1845, at 5 P.M., Miss M—— B——, ætat. 40, was suddenly seized, whilst seated quietly before the fire, with dyspnœa and partial syncope, accompanied at first with convulsions, and afterwards with intense pain referred to the epigastrium, loins, and hypochondria. This condition continued 24 hours, when, after a slight struggle, she expired. The mind was perfect throughout.

2. *History from birth.*—The previous history of this lady is as follows:—Miss B—— was very diminutive in stature, and pigeon-breasted, but without any positive deformity. She had cyanosis from birth, indicated by intense blueness of the cheeks, lips, and tongue. The heart's action (as far as

could be learned from her family) was regular when she was at rest; but running, or going up stairs, or any sudden exertion, produced great palpitation and dyspnœa. She suffered very much from the cold. Her intellect was of average power; and, with the exception of occasional dyspepsia, her general health was good.

Miss B——'s first serious attack, similar to that of which she died, was in October 1840.

In November 1843, Miss B—— had anasarca of the abdomen and lower extremities. The pulse was 100, not weak, but irregular as to number and power. The carotids pulsated visibly, but the jugular veins were not turgid. Of this attack, which lasted three months, she completely recovered, and never afterwards became dropsical.

Her second attack of dyspnœa and syncope was in the beginning of May 1844; her third was in September of the same year; her fourth in February of the present year, six weeks before death; and her fifth, which proved fatal, was in March last.

I may be allowed to state that the four first attacks were precisely similar in character to the fifth, described at the commencement of this paper, but that they differed in being less severe, and in the circumstance that they all followed violent exertion, whilst the fifth came on spontaneously.

Having only seen Miss B—— casually, I much regret that I have no information to offer respecting the sounds of the heart, of sufficient accuracy; I beg, therefore, to close the present history with this additional remark—that she never suffered from rheumatism in any form.

3. *Post-mortem examination* was conducted by Mr. Raymond Gasquet, Mr. Basil Barett, and myself, 42 hours after death, and I am permitted by those gentlemen to add their testimony to the accuracy of the following description:—

Surface of the body was purple in the dependent parts. No œdema even of the ankles. The body was neither corpulent nor emaciated.

Thorax.—The pectoral muscles were flabby, and contrasted

remarkably with the firmness of the heart. There was no fluid in either pleural cavity; and, excepting some old but very small adhesions, and opacity and induration of small parts of the pulmonary pleuræ, these membranes were healthy. The lungs were congested, especially in their posterior parts, which also broke up easily under pressure; but, with the exception of four spots, about the size of shilling-pieces, of miliary tubercles, and red hepatization of the tissue between the tubercles, their structure was healthy.

The pericardium contained no fluid, and was healthy. The heart was very heavy, from the great firmness of its muscular tissue; and although small abstractedly, yet, compared with the size of the body, was somewhat enlarged. The enlargement was principally from hypertrophy of its walls, the dilatation of its cavities being slight. The hypertrophy was chiefly of the right side, the right ventricle being as thick as the left ventricle, and the right auricle three times as thick as the left auricle. The right auricle was also somewhat dilated. The foramen ovale was patulous; and, as it opened into the left auricle, was four lines in diameter. The auriculo-ventricular valves were thickened, but quite moveable. The aortic valves were healthy. The pulmonary artery was so malformed at its root as to render an accurate description of it extremely difficult. Besides the three semilunar valves usually found there, it presented an adventitious membrane situated immediately above them, and stretched completely across the artery, like the diaphragm across the trunk of the body. This membrane was a line in thickness, and perforated in its centre, not by a circular foramen, but by a mere slit two lines in length and a line in breadth, with margins of a red colour, and fringed with fibrine of the blood. The three semilunar valves were thrown up as they are naturally in a healthy pulmonary artery during the systole of the heart, and fixed in that position by the adhesion of (what would have been) their free borders to the adventitious membrane. The ductus arteriosus was impervious.

Abdomen.—The kidneys were of natural size, but a little

granular, and contained many and large cysts. The bladder contained acid urine, which precipitated on the addition of nitric acid, and coagulated to one-fourth its bulk on standing half an hour after ebullition. The other abdominal organs were healthy.

4. *Pathological deductions.*—1st. From the presence of cyanosis immediately after birth, and the total absence of rheumatic fever during life, that the membrane which obstructed the pulmonary artery was a congenital malformation. 2nd. That the marked hypertrophy of the right side of the heart was the consequence of the obstruction in the pulmonary artery. 3rd. From the circumstance that either an obstructed pulmonary artery or a patulous foramen ovale may exist separately without the blue disease, that the cyanosis in this case was the result of the two above-named lesions combined. 4th. That the circulation of imperfectly oxygenated blood impaired no function so much as the formation of animal heat, of which, as we before noticed, Miss B—— was remarkably deficient.

ON THE

GANGLIONIC CHARACTER

OF THE

ARACHNOID MEMBRANE OF THE BRAIN AND SPINAL MARROW.

By GEORGE RAINEY, M.R.C.S.

Communicated by THOMAS HODGKIN, M.D.

Received December 17th, 1845—Read February 10th, 1846.

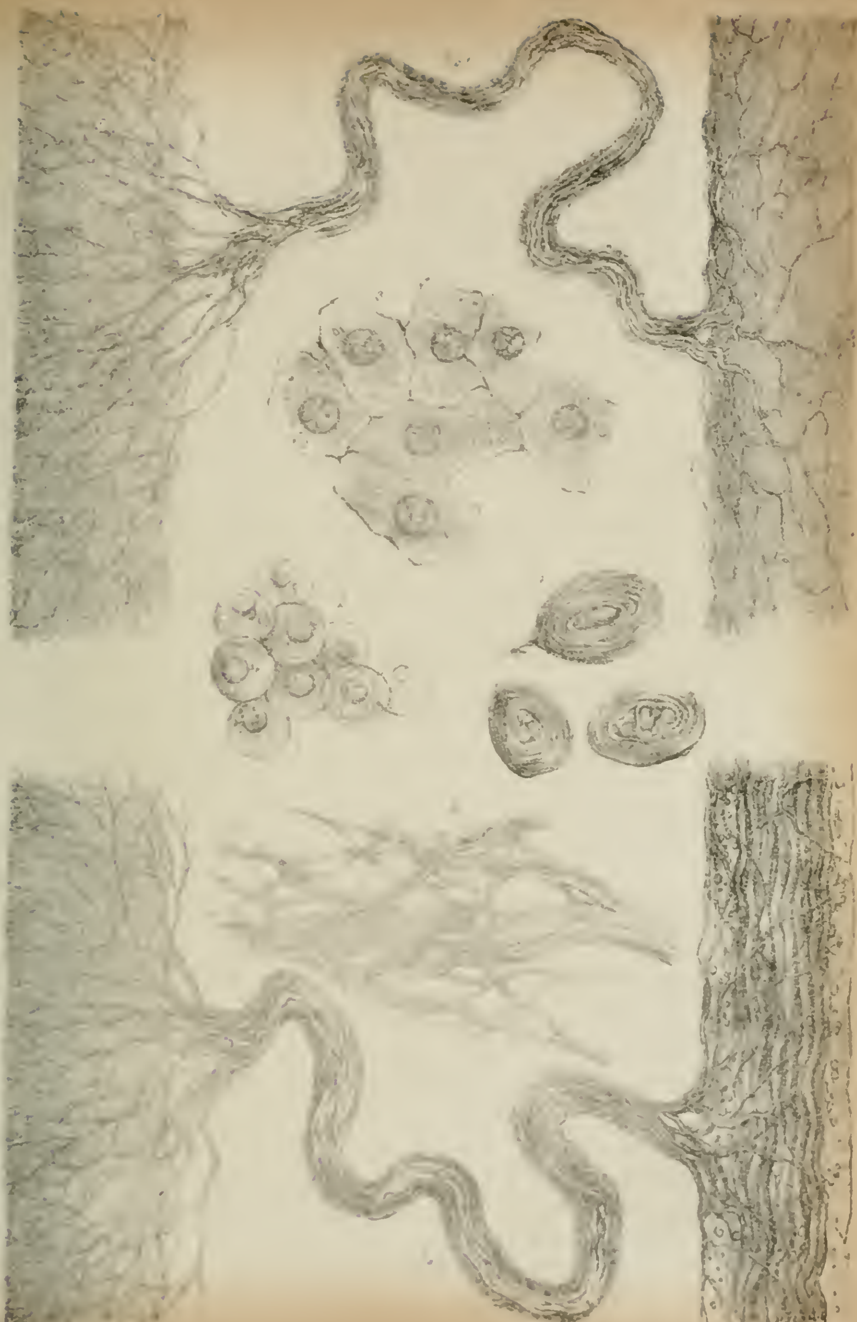
As I believe it has never been supposed by physiologists that there exists within the cavity of the cranium an especial provision of organic nerves for the supply of the cerebral vessels, corresponding to those which, in the abdomen, go from the cæliac ganglia to the vessels of the viscera,—the arachnoid serving as a membranous plexus in which they ramify,—the announcement of this view can scarcely fail to be received by anatomists and physiologists with extreme doubt. Under this impression I have considered it admissible, at the commencement of this paper, to state, that the views herein set forth are based entirely upon anatomical facts which I have endeavoured to describe in such a manner as will most facilitate the verification of their accuracy: for this purpose, also, I have detailed these facts and discussed their physiological application nearly in the order they occurred, whilst occupied in their examination.

The first idea which suggested to me the resemblance of the arachnoid to the sympathetic, was from the examination of a piece of the former taken from the inferior and lateral part of the medulla oblongata, when I observed, at the meeting of two of the chords situated between the arachnoid and pia mater (called by Magendie, " Tissu cellulo-vasculaire subarachnoide"), a triangular body of the form and general appearance of a ganglion, very similar to such as I had seen in small animals.—(See Plate II. fig. 5.)

This resemblance appeared more striking on observing a branch going from the chord connected with this body, to the arachnoid membrane, along which it ran for a considerable distance, dividing and subdividing in its course, in the manner of a nerve; the successive subdivisions becoming more and more minute, and at the same time interlacing and enclosing small areolæ filled with corpuscular matter. These corpuscles were so blended with the ultimate filaments of this chord as to render indistinct their exact mode of termination. —(See Plate II. fig. 4.)

Such was the connection of one extremity of one of these chords. The next point to be determined was the structure to which the other extremity of the same chord had been attached. As, in this case, it had been separated from its connection, this could only be ascertained by examining similar chords in other portions of membrane. This examination being made, I found that the end in question terminated either on an artery or on a cerebro-spinal nerve. In the former case a chord, as soon as it comes in contact with an artery, divides into branches which ramify upon it, and run along its external coat, just as, to all appearance, the branches of the solar plexus do on the small arteries supplying the viscera in the abdomen.—(Plate III. fig. 1.) If the cerebral artery be rather large, and situated between the arachnoid and pia mater, some of the branches going from a chord form upon it a plexus, and others proceed onwards to the vessels of the pia mater.

In some instances a chord passes from an artery to the



arachnoid without dividing in its course, as just described; but more frequently on approaching the latter it sends off three or four large branches, which pass to different parts of the membrane, and ramify in it, as before explained; however, sometimes one of these branches either itself expands into a large dense plexus, or joins other branches to form one, from which plexus two, three, or more chords pass into the substance of the arachnoid. The shape of these plexuses is either square or triangular, according to the number of branches which join them, and the number they give off. Besides consisting of interlacing fibres, they also contain corpuscular matter.

The arachnoidal extremity of some of the chords connecting the vessels with the arachnoid of the cauda equina expands close to the membrane, into a large oblong and rather oval bulb, the axis of which is occupied by a continuation of the chord, extremely convoluted and bent upon itself; whilst, inferiorly, its fibres are blended with those of the membrane. —(See Plate II. figs. 7 and 8, which exhibit representations of two of these expansions.)

The chords which pass from the vessels of the pia mater, at the upper portion of the brain to the arachnoid, terminate in the latter by fibres having a stellate arrangement. There are also some large triangular plexuses like those at the base of the brain, from which branches descend between the convolutions to the vessels within the sulci.

In the lower animals, as in the sheep, in which the cerebral convolutions are small, the stellate fibres are the best seen. They can even be distinguished by the naked eye, appearing like minute opaque points. At their centre, the fibres of which they are composed, seem to be blended into an irregular confused mass, from which other fibres radiate, and lose themselves in the cerebral surface of the arachnoid. Some fibres go from one stellate body to another, and others can be traced into the coats of the vessels: these latter are by no means numerous. Branches also descend (still having somewhat the stellate disposition) between the convolutions, to the

deep-seated vessels; these filaments are much more numerous upon some vessels than upon others, and they do not appear to extend so far as the capillaries, no fibres of any kind being visible upon this system of vessels.

It appears, from what has been stated, that the disposition of the ramifying filaments of the arachnoidal chords, and the form and size of the gangliform plexuses connected with them, bear some proportion to the number and size of the vessels in their vicinity. Hence, about the base of the brain, where the branches of the arteries are large, the plexuses are also large, and of an irregular shape, whilst on its upper surface, where the vessels are comparatively small, and more equal in size, and have a more uniform distribution, the plexuses also are smaller, more numerous, and more regular in their shape and volume.

Besides the plexuses situated in the course of the chords of the arachnoid, there are others which are more intimately connected with its cerebral surface, and which, in some situations, appear to compose the entire thickness of the membrane.

In these plexuses, the filaments interlace very much in the same manner as the nerves do in the plexuses of the cerebro-spinal and sympathetic systems. A chord, for instance, when traced into one of them, will be observed to break up into its component filaments, the adjoining bundles of which interlace, yielding to one another one or more bundles, and the chords which emerge from the plexuses deriving their component filaments from different bundles: these bundles, and their component threads, during their interlacing, will be seen to preserve their individuality.—(See Plate III. fig. 6.)

When a chord going from the arachnoid, terminates on a cerebral nerve, it divides in the same manner as on an artery, some filaments ascending and others descending, along with the nerve tubules. In some instances this extremity terminates in a sort of membranous expansion, which encloses several nerve tubules.—(Plate III. fig. 5.)

As this apparatus of ramifying chords and plexuses is neither vessels nor cerebro spinal nerves, it occurred to me that it must, therefore, be either cellular tissue or organic nerve fibres. By cellular, elastic, or filamentous tissues, considered simply as such, physiologists understand a structure whose office is exclusively mechanical.

Now, it appears to me quite obvious, on considering the relations of these chords and their appendages, with respect to the parts to which they are attached, that they are intended to perform something more than a mere mechanical office.

Some of these chords are three-fourths of an inch in length, whilst, between the vessels on which they ramify and the arachnoid, when these parts are in their natural situation, there is not, probably, a quarter of that distance.

Besides, the dense and comparatively massive plexuses, which are situated in the course of some of these chords, and the expansions into which others terminate, just before they join the arachnoid, cannot in any way strengthen the connection between the membrane and the vessels, or enable the one to support better the weight of the other.

It is possible, that any one who may have observed the "tissue cellulo-vasculaire" only in a general way, may suppose it to be intended merely to divide the space which contains the cerebro-spinal fluid, as the cancelli do the cavity of some bones. There appears, however, no resemblance whatever in these structures which warrants such a conclusion.

Lastly, the circumstance of these chords dividing and ramifying like an artery or a nerve, is a character which is not possessed by mere fibrous bands in other parts of the body. Mandl, in speaking of the characters of cellular membrane, observes, "Les fibrilles du tissu cellulaire ne se ramifient jamais." This character, more especially when viewed in connection with the fact of many of these chords being connected with plexuses, seems to indicate that they are concerned in the performance of some vital function, the ramifications at one

extremity of a chord being to collect some influence generated in the arachnoid; and the trunk, and the ramifications at the other end, serving to convey and distribute that influence to the parts requiring it, or, in other words, that they perform the function of nerves.

For the purpose of testing the correctness of this conclusion, I compared the filaments composing these chords, and various parts of the arachnoid itself, with nerves undoubtedly sympathetic. The comparison was made chiefly with branches from the solar plexus, both in the human subject and in other animals.—(Plate II. figs. 1, 2, and 3.)

In the chords of the arachnoid, I could distinguish three different kinds of filaments, all which exist in the branches of the sympathetic.

One species generally considered the most characteristic, is the nuclear fibre described by Henle; it is a flat, clear fibre, with oval, nearly equidistant nuclei, and each having its long axis corresponding to that of the fibre. I have found these fibres in the arachnoid, but they are very rare. I have seen such going from the arachnoid to the coat of the internal carotid, the trunks being blended with the membrane, and the branches connected with the artery. I also found, that as the fibres branch off from these trunks, and intermix with others, they lost their nuclei, became more pale and clear, and differed in no respect whatever from the other fibres of the membrane. Besides, I have seen these fibres in other parts of the membrane, and they exist chiefly on the exterior of the larger chords. (Plate II. fig. 10, represents some of these fibres as found in the chords of arachnoid.) This species of fibre I have also found to be very uncommon in the smaller branches of the nerves confessedly sympathetic, especially in those most remote from the ganglia and larger trunks. The next kind of fibre is one consisting of bundles, for the most part rather smaller than nerve tubules, of very minute wavy filaments, intermixed with small particles of granular matter, having no definite form, size, or position in respect to the filaments. Some of the chords of the arachnoid are made up entirely of

fibres of this description; in others they exist chiefly on their surface, being most abundant near their attachment to the arachnoid, upon which they are continued. This kind of fibre exists abundantly in all the branches of the nerves undoubtedly sympathetic; and also, more or less, in those connected with the ganglia. The third kind of fibre occurs in the form of roundish, though sometimes flat chords, composed of extremely minute wavy filaments, either collected or not, into bundles, but apparently interwoven somewhat together, so that, generally, a filament of only an inconsiderable length will admit of being detached mechanically from the rest, and, when thus separated, its breadth is very unequal, and its contour ill-defined. These filaments are often totally destitute of granular matter.

This last species of fibre is very common among the chords composing the plexuses of the arachnoid; it is also sometimes situated in the centre of the larger ones, surrounded by the second species of fibre; this can be detached mechanically, and exhibited separately under the microscope.

In the nerves obviously sympathetic, this kind of fibre exists in considerable abundance in those branches of the solar and other plexuses which are most remote from the ganglia.

After having satisfied myself of the resemblance of the fibres of the arachnoid to those of the branches of the sympathetic, I exhibited some preparations of both structures, that is, both arachnoid and sympathetic fibres, to different anatomists, some of whom pronounced them to be merely cellular, or elastic tissue, and others to be decidedly organic nerves.

This discrepancy of opinion, partly due to a notion which is entertained by Henle, that the sympathetic is only to be distinguished by a particular form of nuclear fibre, induced me to re-examine this subject with every possible care.

Although aware that Henle's opinion does not agree with some of the more recent examinations of this nerve by other authors, I shall, in the place of referring to authorities upon

this point, briefly give the result of my own investigations, and the manner in which they were conducted.

A part well adapted for the examination of the sympathetic, is one in which a considerable length of nerve can be displayed continuously; the mesentery of the cat, or rabbit, presents this advantage. Having dissected out branches of the mesenteric plexus in these animals, extending from the centre of the mesentery to the intestine, I examined them in such a manner with the microscope, as always to be certain, by their continuity, that the part under observation was sympathetic nerve. In these nerves, and their various branches, I could distinguish the three descriptions of fibre already mentioned, and which it would, therefore, be unnecessary to repeat; however, I may observe that I was enabled to satisfy myself of two facts, namely, that of the total absence of anything like a nucleus, or even of granular matter, of any description whatever, in many of the minute branches, these being composed entirely of clear, wavy filaments;* and of the fact of an entire absence of nerve tubules, in by far the majority of the most minute branches.†

From the foregoing observations, it appears that although the characters of the sympathetic, whether connected with the arachnoid, or found in structures confessedly ganglionic, are in some branches sufficiently characteristic, yet that in others, these fibres resemble so much simple cellular or elastic fibre, as not to be distinguishable from it by any single microscopic character. To determine, then, the nature and office of filaments of this description, it will be necessary to consider, in conjunction with their microscopic appearances, their general characters, more especially their form and mode of division, and their relations, as well anatomical as physio-

* By an inexperienced observer, the particles of oil which become mixed with the filaments of the nerves whilst dissecting them out from the surrounding adipose tissue, may be mistaken for nuclei, or granular matter.

† This last fact is important, inasmuch as it goes to disprove the opinion entertained by some physiologists, that the sympathetic is not, in itself, a distinct nerve, but is made up, in all cases, of cerebro-spinal nerve tubules, and organic fibres.

logical, to other parts. Now, combining all these considerations, and observing that, as the filaments which go from the sympathetic plexuses to the vessels of the viscera, resemble so much those going from the arachnoid to the cerebral vessels, that no difference between them is distinguishable by the microscope, either in their structure or their mode of distribution to the vessels, there is the strongest rational evidence in favour of their office also being the same; and as they spring from the arachnoid and go to the cerebral vessels, that the arachnoid is as much a source of organic nerves (nervi vasorum), as are the plexuses from which filaments go to the vessels of the kidney, or other viscera.

Thus far my observations have been confined to the structure of the fibres of the arachnoid, and their supposed use. I will now consider the corpuscular, or ganglionic part of this membrane. Some of the plexuses on its cerebral surface have the interstices, formed by their interlacing fibres, completely filled up with small roundish corpuscles, about the size of blood-discs; whilst, in others, these fibres are covered with irregularly-oval masses of them. On this surface also, in various situations, there are well-defined round or oval bodies, having in their centre a granular nucleus surrounded by fibrous tissue, intermixed with more or less corpuscular matter. Some of these bodies are connected to the fibres of the arachnoid by a very fine thread, others are situated at the conflux of two or more fibrous chords (see Plate II. figs. 6 and 9), and their diameter varies from that of two to seven blood-corpuscles. They are generally solitary, and not numerous; but as they have been present in the arachnoid of every human subject which I have examined, (a number exceeding twenty,) they cannot be regarded as accidental or adventitious. At present I cannot decide as to their nature or office, not having seen anything which they exactly resemble in other parts of the body; at any rate, they look more like small ganglia than anything else I have seen.

Besides these corpuscles, which, as before stated, exist on

the cerebral surface of the arachnoid, I have met with some of a very different character, situated in its substance, though nearer to the cranial than to the cerebral surface. The most ordinary appearance which these present, when seen by transmitted light, is that of a section of an urinary calculus made through its centre, appearing, like it, to be made up of concentric layers. When viewed by reflected light, these bodies seem to be vesicular, and filled with fluid, the quantity of which appears to diminish as the number of layers increases, so that those in which the laminæ have extended as far as the centre, are almost flat. Although the most frequent form of these bodies is circular, yet some are oval; occasionally they are connected with a fibre of the arachnoid, in such a manner as to resemble small Pascinian corpuscles. One remarkable fact connected with these bodies is, that they occur in the arachnoid of almost every subject which I have had an opportunity of examining, and that no part of the membrane is exempt from them; generally they are solitary, and very sparingly distributed; but sometimes they are in clusters. I have found them in the internal Pacchionian glands mixed with granular matter, and the same kind of fibre as exists in most parts of the arachnoid membrane. Their diameter varies from ·75000 to ·39800 of an inch. I have observed on some parts of the arachnoid, in the vicinity of a cluster of these bodies, cavities of a similar shape and size, from which the corpuscles themselves appeared to have been dislodged. From this circumstance, as well as from the general aspect of these bodies, they seem to me either to be structures altogether adventitious, or the result of an abnormal deposition in diseased corpuscles. The tendency which they may be observed to have to coalesce when several smaller ones occur together, evident by the obliteration of those portions which seem pressed against one another, and the union of the remote segments to form a single outline enclosing an area whose figure clearly indicates the number of corpuscles which have united to form it, proves them to be something more than mere earthy de-

posits, such as are sometimes found in the choroid plexuses, or even than mere scrofulous tubercles.—(See Plate III. fig. 4.) Vogel has found bodies similar to these in the choroid plexuses; in these, and in the pia mater, Dr. E. Harless has also seen them, and given a very minute account of their structure, in a number of Müller's Archives, 1845. This author seems to think that their seat is in the arteries, and that they are somewhat allied to ossification of these structures; but their occurrence in all parts of the arachnoid, in some of which there are probably no vessels, is opposed to this view.

The organs connected with the arachnoid, which to me seem to correspond in their structure, and therefore in their function, to the ganglionic corpuscles of the sympathetic, are the globular bodies which cover the villi of the choroid plexuses. Before considering their minute structure, I will make a few observations upon their general connections.

The choroid plexuses are generally admitted to be portions of the membranes of the brain. They are situated in the lateral and fourth ventricles, and a considerable portion is placed upon the external surface of the cerebellum against the inferior vermiform processes. They are composed of the terminal loopings of the cerebral vessels, which are accompanied by chords going from the arachnoid membrane, some of which are more or less intimately connected with the coats of the vessels, others merely accompanying them to their ultimate villi, and appear to become lost in the membrane covering the vessels. These chords also accompany the individual vessels going from the choroid plexuses to different parts of the internal surface of the ventricles. The surface of the choroid plexuses, both within the cavities and on the external surface of the brain, is covered by a layer of globular bodies, each of which has a diameter nearly equal to two blood-corpuscles. In the sheep they are rather larger than in man. This layer of corpuscles is generally considered as a species of tesselated epithelium, and as such is represented by Valentin in his plates, each corpuscle being represented as an hexagonal

flat scale, with a round nucleated cell in its centre.—(See Plate III. figs. 2 and 3.)

To show the inaccuracy of this idea, and to observe the true structure of these bodies, the free edge and adjoining surface of a villus of the choroid plexus ought to be examined, without being in the least compressed, with a lens of one-eighth of an inch focal distance, and the decided convexity of the free margin and surface of each corpuscle will show that its form is spherical and not flat, and that it is a vesicular body, and not an epithelial scale. The contiguous portions of the vesicles, remote from the free margin of a villus, being pressed together, will be somewhat flattened, and those which are thus compressed on all sides, rendered polyhedral; but, if some of them be detached and isolated from one another, their circular figure will be more or less restored. As these corpuscles contain very fine molecular matter, whose colour is deepened by the action of weak spirit, their true form may be best seen in those which have been kept for some days in this fluid. If a villus, thus prepared, be viewed by the microscope, the line of separation between one vesicle and another, instead of appearing to be rectilinear, and situated between two flat surfaces, as in a tesselated epithelium, will be observed to be curved, and placed at the bottom of a groove formed by the meeting of two dark grey convex surfaces.—(See Plate III. figs. 2 and 3.) Besides the molecular matter contained in these vesicles, there is also in each a distinct eccentric nucleus, which, when freed completely of all adherent matter, looks clear and well defined; it has generally within it one or two nucleoli. The nuclei are best seen when the part is perfectly fresh, as the contents of the vesicles, when darkened by spirit, or from any other cause, make them appear indistinct; and that part of the plexus choroides which is situated external to the fourth ventricle upon the vermiform process of the cerebellum serves best for this purpose. As respects the ciliary motion, discovered by Purkinje, on the lining membrane of the ventricles of the brain, and the vesicular bodies upon the plexus choroides, I may notice that I have looked for it on

EXPLANATION OF THE PLATES.

Plate II.

Fig. 1.—Shows a portion of the sympathetic nerve from the mesenteric plexus of a woman.

Fig. 2.—A branch of the sympathetic nerve of the snake.

Fig. 3.—A portion of one of the chords connecting the arachnoid with the cerebral vessels.

Fig. 4.—The mode of division, and ramification of the arachnoid, in the arachnoid membrane.

Fig. 5.—A triangular gangliform body situated at the conflux of three arachnoid chords.

Fig. 6.—Some of the corpuscles connected with a plexus of the arachnoid.

Figs. 7 and 8.—Expansions in which the arachnoid chords terminate in the arachnoid of the cauda equina.

Fig. 9.—One of the corpuscles situated at the conflux of three chords.

Fig. 10.—Some of the nucleated fibres in the chords of the arachnoid.

Plate III.

Fig. 1.—Shows a chord connecting the cerebral surface of the arachnoid, with a cerebral vessel.

Fig. 2.—The corpuscles on the free edge of a villus of the choroid plexus.

Fig. 3.—A portion of tesselated epithelium.

Fig. 4.—Some of the concentric bodies situated in the arachnoid.

Fig. 5.—A chord connecting the cerebral surface of the arachnoid, with a cerebro-spinal nerve.

Fig. 6.—The disposition of the fibres forming the plexuses on the inferior surface of the arachnoid.

the latter, without seeing it. If, however, there be ciliary motion upon these vesicles, it ought not to be confined to the ventricles of the brain, since some portion of these plexuses are situated also on its exterior. Now, on comparing the corpuscles attached to the choroid plexuses with those of the grey matter of the brain and the ganglia of the sympathetic, I found a very striking resemblance, especially with the latter. In their essential characters, there is an agreement as close as exists between identical structures in different subjects, or in different parts of the same subject, the corpuscles in all these cases being characterized by a delicate transparent membrane filled with very fine molecular matter, and containing an eccentric nucleus, having generally a nucleolus or nucleoli. From this resemblance in their structure it seems to me not improbable that there may be something in common in their function. The only theory which can be put in opposition to this is, that the plexus choroides may possibly serve for the secretion or absorption of fluids. (See Dr. Todd on the Nervous Centres, Cyclopædia of Anatomy, &c.) Had this been the case, one would have expected to find some character common to all the parts with which these plexuses are in contact, indicative of one common office;—either there would be something provided to receive the fluid they give out, or to supply them with that which they are required to take in; now, as the dissimilar character of the many and various parts with which these organs are connected indicates the existence of no such provision, this theory seems to be without support.

I may here observe that I do not imagine every part of the arachnoid to be nervous, but that this property exists in those which are made up of soft corpuscular matter, and the ramifications of the chords going to the arteries and nerves. The adjacent surfaces of the arachnoid and dura mater are covered in parts with tesselated epithelium; and, in some situations, these membranes are continuous one with another; but the entire thickness of the former does not line the cerebral surface of the latter: the stellate and ramifying fibres of

which the inferior surface of the arachnoid is, in a great measure, composed, being continued upon the vessels of the pia mater, render such a mode of connection between these membranes impossible. The arachnoid is unlike other serous membranes, in having, in different situations, characters altogether dissimilar—in some being thin, soft, transparent, and granular; in others, thick, strong, opaque, and fibrous (these differences in many cases not being explicable upon mere mechanical grounds): also in its relation to other parts, the visceral portion of the arachnoid, instead of being closely connected with the part it invests, and thus having but one surface free, like the pleura, &c., is separated from it by the intervention of other structures, for instance, by the pia mater, by fibrous chords and plexuses, and, in some situations, by a quantity of fluid, and, consequently, it has two free surfaces; this is especially the case at the base of the brain. It appears also to possess a higher state of sensibility and a more direct and extensive connection with the cerebro-spinal nerves than other serous membranes, as shown by an experiment performed by Mr. Henry Smith, and related by Dr. Marshall Hall, in which, after the removal of the brain from a dog, the arachnoid, lying loose at the bottom of the cranium, about the medulla oblongata, was pinched, and convulsions of the face and other parts of the body were instantly produced. (See Medical Times, vol ii. p. 294.)

The arachnoid, besides being continuous with the dura mater by its epithelial layer, is also connected with it by fine threads, some of which appear knotted, and others tubular. The external surface of the spinal arachnoid, especially at the posterior part of the *theca vertebralis,* is also attached here and there to the dura mater by similar threads, some of which are connected by both their extremities to this membrane, whilst the middle part is enclosed in a tubular process of the arachnoid. These threads are altogether distinct from the ligamentum denticulatum.

The middle septum, extending from the posterior part of the pia mater to the arachnoid, contains ramifying fibres,

which go from the latter to vessels situated behind the pia mater, between it and the arachnoid, and, also, to the vessels of the pia mater itself.

As respects the supply of vessels and cerebro-spinal nerves to the arachnoid, I may observe, that the arteries are few, but rather large, almost sufficiently so to receive a small injection tube; (I have preparations of these;) and that cerebro-spinal nerves may be traced into its visceral portion, and, with the microscope, their tubules can be seen running along with the arachnoid fibres, into which they appear, from the gradual loss of their tubular contents, to degenerate.

The soft texture and expanded form of the arachnoid may, at first sight, appear at variance with the notion of its being nervous; such, however, is the common appearance presented by the sympathetic in other parts of the body. Upon this subject, Mr. Swan, whose splendid work upon the nerves is well known to anatomists, observes, that "many are apt to be too much guided by notions they have early imbibed respecting the form, substance, &c., of various parts of the body, and cannot at first reconcile it to themselves, with regard to the nerves, that anything in the form of a thin membrane can perform the function of a round, thick, rope-like substance." (Swan on the Nerves, p. 35.)

And just as nerves pass from these expansions to the mesenteric and renal arteries, so do they pass from the arachnoid to the arteries of the brain. Indeed, if the brain received no other organic nerves than those which it derives from the ganglia in the neck, it seems to me that its supply of these nerves, compared with that which other organs receive, would bear no proportion to the very large quantity of blood which circulates through it, and to the activity of the function which it performs.

According to this inference, it might be expected also that the distribution of the sympathetic to the extremities would be more general than anatomists are disposed to admit. However, upon this subject there is great diversity of opinion, some anatomists regarding structures as sympathetic nerve,

which, by others, are said to be *merely* cellular membrane. Mr. Swan describes and depicts branches going from the nerves of the extremities to the vessels, ligaments, and bones. One of these branches he describes as follows :—"The continuation of the spiral underneath the anular ligament forms a gangliform enlargement upon the capsular ligament of the wrist, which gives off small branches to be distributed on the capsular ligaments and the tendinous sheaths at the back of the wrist." (Page 28, Plate XXIII.) Since then, all the nerves going to the joints have been described as being of a grey colour, and having upon them gangliform enlargements. Now, in addition to these anatomical facts, the circumstance of these nerves supplying parts which are as much organs of secretion as the glands in the abdomen, would lead one to believe that they really are sympathetic nerves. I have examined some of those filaments, and found them to be composed chiefly of yellowish fibres.

Remak, in reference to the nerves of the skin, observes, that they are accompanied by delicate fibrils, which they quit when the nerves proceed to form their terminal plexuses, the fibrils being then seen to form a net-work in their meshes. To these fibres Gerber is disposed to attribute a vital function, thinking it possible that they may serve as subordinate means of conducting nervous influence. The secretion of the skin and kidneys are influenced, the one very much by the other; and if the latter require, for the performance of its functions, a distinct plexus of sympathetic nerves, why ought not the former? About two years ago, I observed that the nerves supplying the skin were so intimately connected with a large quantity of minute fibres as with difficulty to be separated from them, and that, in this respect, they differed from those nerves going to the muscles. This difference I proposed at that time to Mr. Grainger as a means of distinguishing nerves of sensation from nerves of motion. However, it does not exist with respect to the roots of the spinal nerves from the spinal marrow.

The following fact, noticed by Todd and Bowman, seems to

throw some light upon this subject. These authors observe, that, "in dissecting the connections between the sympathetic and the spinal nerves, we find that, for the most part, two distinct fascicles connect them, one of which is *white*, being composed of tubular fibres; the other is *grey*, and consists of gelatinous fibres."

Now it seems to me to be very probable that these grey fascicles are, in reality, the origins from the spinal ganglia of those portions of the sympathetic nerve which are to be distributed to the extremities, and that they attach themselves to the spinal nerves in this situation, as being most convenient; then accompany their divisions to the extremities, as the same system of nerves in the abdomen accompanies the arteries; and, lastly, that they run with the branches of these nerves, by which they are conducted to their destination. Those, for instance, which go to supply the secretory apparatus of the skin, run with the nerves of touch; hence it is for this reason that these nerves are so abundantly accompanied by grey filaments as above described; whilst those which go to the joints, for the secretion of synovia, accompany the nerves passing near to these parts for a certain distance, and then leave them to go to be distributed with the arteries secreting the synovia, as was observed of the branch of the spinal nerve noticed by Mr. Swan. The fascicles of tubular fibres, mentioned by these authors, probably proceed from the spinal nerves to the ganglia, and afterwards accompany their branches to the parts supplied *chiefly* from this system of nerves, to which is due that obtuse state of sensibility possessed by certain parts,—as, for instance, serous and fibrous membranes,—a sensibility, however, so low as only to be made perceptible, and the nervous connection of these parts with the brain rendered evident, by the pain which is referred to them when they are in a state of disease. It is rather strange that, in spite of such physiological proofs of the existence of nerves in these structures, physiologists are so much averse to admit parts entering into their composition, and having the general characters of nerves, to be such. If, in

a transparent sensitive membrane, as the arachnoid, which admits of being fully examined by the microscope, there are certain fibres disposed in the manner of a nerve, either these are in reality nerves, or the microscopist ought to be able to point out those structures in this membrane which are nerves. If he will not admit the one, and cannot do the other, then he *must* yield to the conclusion that all the *other* fibres, excepting these, which enter into its composition, nervous and not nervous, resemble one another so much, and are so similar in their appearance to cellular tissue, that those of them which perform a vital function (evident from the sensibility of the membrane) cannot be distinguished from those which perform a mechanical one, and therefore, that all the positive *anatomical* characters which distinguish nerves in their more perfect state of organization, are absent in those which enter into these structures, or, at least, that they cannot be recognized by the microscope. This consideration shows that if, in these cases, it is difficult to decide with certainty as to what is a nerve, it is quite as much so to say what is not one; and that the mode of disposing of the difficulty by calling almost every fibrous chord or membrane which has not in it a certain kind of nucleated fibre, "merely cellular tissue," is as erroneous as it is unphilosophical.

AN

ACCOUNT OF A CASE

OF

PARTIAL DOUBLE MONSTROSITY.

(ISCHIOPAGE SYMELIEN OF GEOFFROY SAINT-HILAIRE, HETERADELPHIA OF VROLIK.)

By WILLIAM ACTON, Esq.,

SURGEON TO THE ISLINGTON DISPENSARY.

Received March 9th—Read March 10th, 1846.

The subject of the present monstrosity is a healthy male child, named John Baptist Dos Santos, a native of Portugal, 6 months old, and whose singular conformation the Fellows have this evening had an opportunity of personally examining. The father and mother are both healthy, of short stature, and dark complexion: no peculiarity of any kind has been observed in any of their family. The mother states she has had two other children, the eldest, a fine girl, now three years of age; the second, a boy, perfectly well formed, who died when 17 months old. She remarked nothing unusual during her pregnancy; the child was born at the full time, and the labour was an easy one. As the child presented peculiarities which her medical attendant believed to be unique, the parents determined to come to London to exhibit the infant, and I was requested to see the child, which is characterised in a printed paper as "The Human Tripod, or three-legged child, and first Bipenis ever seen or heard of."

The child is exhibited lying on its back in a little cot; is lively and good-looking, and well proportioned, both in the upper and lower extremities, the peculiarities being confined to the parts below the umbilicus; a truss is worn on account of an umbilical rupture. Below the umbilicus, and to the right and left of the mesial line, are two distinct penes, each as large as the penis of a child of six months old: their direction is normal. I may mention that water passed from both organs at the same moment, during the time that Dr. Cursham and Mr. Perry were examining the infant with me. Each penis is provided with a scrotum, the outer half of each scrotum containing one testicle, the inner half of the scrotum is far removed from the outer, and the two inner halves appear like another scrotum between the two penes. Between and behind the legs of the child, we see another limb, or rather two lower extremities united together in their whole length. The upper part of this compound limb is connected to the rami of the pubis by a short narrow stem half an inch in length, and as large as the little finger, apparently consisting of separate bones or cartilage, for, on moving the compound limb, at the same moment the finger is kept on the stem, crepitation is felt, but I could not detect any pulsation. Immediately beyond this stem, and concealing it, the compound limb assumes a size as large as the combined natural thighs of the child, and within the upper part irregular portions of bone may be felt (probably a portion of a pelvis and the heads of the thigh bones), which may be traced down, united together into one mass, to a leg of comparative small size, though still larger than either of the healthy legs, and terminated by a double foot in the position of *talipes*, with the sole turned forwards, and furnished with ten toes, the two great toes being in the centre of the others: the two outer toes on each side are webbed.—(See Plate IV. figs. 1 and 2.)

When the child is placed on its belly, the spine and back present a perfectly normal appearance; the anus is in its usual situation; the functions of the bowels are duly performed.

Viewed in this position, the compound limb assumes a roundness and fullness equal to the buttocks of a young child, and a slight depression is observed, as if for the anus. Tracing the limb downwards, we find only one patella, which is on the same aspect of the limb as the anus, the joint bends freely, and the compound extremity terminates as above described. This compound limb is quite motionless, the upper portion alone appears endowed with sensibility, its vitality seems low, as the toes have a bluеish appearance; the upper portion, however, is of the same temperature as the body of the child.

Observations.

I have consulted most of the original works referred to by authors who have described this species of monstrosity, and I am unable to find exactly analogous cases. Double, or partially double, monsters, are usually united by ligamentous bands at the sternum, as witnessed in the Siamese Twins. In other instances we find two more or less perfect pelves, the rami of which, instead of uniting at the symphysis, pass forwards and are attached to the rami of the opposing monstrosity, thus forming one large pelvis in common. In these last-named monstrosities, the external genital organs are either very imperfectly formed, or placed in their usual situation on either half of the monster; but I am unable to find any description or plate of two penes on one body, as in the case before the Society. The Fellows, I think, will agree with me in believing that this instance of double penis does not depend upon a division of one organ; the distance at which they are placed one from the other, the existence of two canals, by which urine passed at the same moment, renders this little probable. I did not like to press the parents to allow me to pass catheters, on account of the tender age of the child, and I am, therefore, unable to say if two bladders exist, or if the two canals communicate.

In reference to the compound limb, science possesses several instances, which may be found referred to by authors who

have treated of monsters; I need not therefore, dwell upon the subject further than to remind the Fellows that this form of monstrosity has given rise to the fabulous stories of mermaids, and the webbed toes have given some further countenance to a supposed resemblance of this compound limb to the tail of a fish.

The only other point to which I wish to call the attention of the Society, is the question of removal of this compound limb. In cases bearing the nearest resemblance to the present one, death has followed so soon after birth, that an operation has not been necessary; in the cases of double monsters like the Siamese Twins, it has not been thought advisable to operate, as the surgeon would have probably divided the peritonæum, which formed a common sac to both monsters; but in the present case, every circumstance is in favour of an operation. The health of the child proves the existence at least of one entire set of healthy organs, capable of performing all their functions; the medium of communication is narrow, and contains probably no important part; but what especially demands the attention of the parents, is the low vitality of the limb; with every precaution that can be taken, the toes have now a blueish appearance, and the history of partial double monstrosities shows, that any, however slight, scratch or contusion heals slowly, and generally ends, at first, in the death of the part, and subsequently of the child.

If the infant escapes this source of danger, its system is found incapable of supporting this additional limb, and the child perishes from debility. There can then, I think, be no doubt that an operation will be necessary, to give the child a chance of arriving at puberty; and in the absence of any one counter indication, I think all will agree, the sooner this is performed the better, for the security of the child.

EXPLANATION OF PLATE IV.

Fig. 1.—Exhibits the child lying on its back in a little cot. The artist has been careful in delineating the two distinct penes, and the outer half of each scrotum, containing one testicle, with the rudimentary parts of another scrotum between the penes. In this position the compound limb is seen, terminated by a double foot in the position of talipes, with the sole turned forwards, and furnished with ten toes, the two great toes being in the centre of the others; the two outer toes on each side are webbed.

Fig. 2.—Represents the child placed on its belly. A depression is seen on the compound limb, as if for the anus. The patella is seen on this aspect, and we have the front view of the compound foot, terminated as above described.

SOME REMARKS

ON

WOUNDED ARTERIES, SECONDARY HÆMORRHAGE,

AND

FALSE ANEURISMS.

By ROBERT LISTON, F.R.S.,

SURGEON TO UNIVERSITY COLLEGE HOSPITAL, AND VICE-PRESIDENT OF THE SOCIETY.

Received April 6th—Read April 14th, 1846.

The subject of wounds of arteries, with the consequences of such wounds, immediate and remote, has possessed, and always must possess, great interest in the eyes of the surgical practitioner. My impression, until very lately, was, that no subject had been better handled, or was better understood by surgeons generally, and that all writers were pretty well agreed as to the rules which ought to guide the practice in such cases. As, however, the propriety of the treatment adopted in the following case has been called in question, I propose to relate very shortly its leading features, and to support the line of practice pursued, by a reference to, and relation of, some similar instances.

Mr. S., ætat. 28, an exceedingly corpulent person, who had, it appears, lived very freely for a series of years, was wounded on the 20th of May 1845, by a pistol bullet. It entered the upper and outer part of the right thigh, a little above, and in front of, the trochanter major, and passed out in the middle of the fold of the left groin, thus traversing the course of the femoral vessels. The flow of blood, more especially from the wound on the right side, was described to have been most impetuous and profuse, being thrown in jets to a considerable distance—it was said, two or

three feet. The patient was found by Mr. Jenkins, of Gosport, who was first called to his assistance, in an almost lifeless state, and he was with great difficulty recovered from the syncope and depression. The line of the ball could be distinctly traced by the discolouration and slight elevation of the skin; and a considerable swelling from extravasation of blood, soon supervened over the lower part of the abdominal parietes.

May 27, the seventh day from the receipt of the injury, the swelling in the right groin began to increase in size, and distinct pulsation was then, for the first time, perceived in it. The tumour went on increasing gradually and progressively, and it had gained much more in bulk on the 10th day, when I first saw him, than it had done on any of the preceding ones. It was of an oval form, and extended from a little within the anterior superior spinous process of the ilium, to the linea alba. It projected but slightly over Poupart's ligament upon the upper and inner part of the thigh. It was elastic, but firm, as if partly made up of coagulum and liquid blood; but it could not be at all diminished in bulk by uniform and continued pressure. Pulsation was strong and distinct in all its parts. The circular opening on the right hip was filled with a dry, depressed slough, and had a slight blush of redness around its margin. The wound in the left groin had the appearance of a jagged slit, and was partly closed by a very thin cicatrix. Near this was a swelling distinct from the other, discoloured on the surface, fluctuating indistinctly, and supposed to contain some bloody, purulent fluid. The patient's countenance was blanched and waxy, and his pulse quick and feeble. He had, in short, all the appearance of a person who had lost a great quantity of blood.

The nature of the case was very apparent. A large false aneurism, not well bounded, and rapidly increasing over the abdominal parietes in the iliac region, and arising from a wound of the femoral artery, or of some branch, divided close to its origin, had to be arrested in its progress,

otherwise the patient must be left exposed to the risk of perishing suddenly, and at no distant period.

After consultations on the evening of the 30th and morning of the 31st, with Drs. Mortimer and Stewart, Messrs. Jenkins, Sampson, and Potter, the external iliac artery was tied, with the loss of not more than a table-spoonful of blood, and with the immediate effect of arresting the pulsation, and of removing in a great measure the tension of the tumour. The corresponding limb, which had been somewhat swollen, was found, on the day after the operation, diminished in bulk, and of its natural temperature.

Symptoms of peritonitis supervened this same evening, and on the following afternoon the patient sunk.

The *post-mortem* examination by Dr. Allan, of Haslar, is here subjoined.

Examination of the body of the late J. A. S., 18 *hours after death.*—Body very fat and muscular; swelling and ecchymosis of the right thigh, particularly at the upper part, and in the right iliac region; also swelling and ecchymosis of the scrotum, chiefly in the right side, with a general tumefaction of the abdominal parietes below the umbilicus.

A wound, into which the little finger could be pressed, was on the upper and outer aspect of the right thigh, about three inches below the crest of the ilium, and about an inch nearer the mesial line than the great trochanter; and, on the left side, another smaller wound, situated about the external aperture of the left spermatic canal.

The first-mentioned wound was open; the lips of the latter were partially adherent. There was also a long, oblique incision in the usual situation of the operation for tying the external iliac artery.

The course of the bullet was traced from the outside, through a dense layer of fat, about two inches in thickness on an average. It had divided one of the superficial branches of the femoral artery, about half an inch below Poupart's ligament, and about an inch from the main body of the

femoral artery, which had caused a false aneurism. The sac contained about three ounces of blood. Blood was also effused into the cellular structure of the scrotum, and downwards beneath the sartorius muscle.

The bullet had passed through the cellular tissue, across the pubes, and emerged about the situation of the external spermatic ring, without having divided the cord on either side, and being quite superficial to the bladder.

No other artery appeared to have been wounded.

When the parietes of the abdomen were reflected, a considerable quantity of sero-purulent fluid was found in the abdominal cavity, and on different parts of the large and small intestines, patches of acute inflammation were observed, particularly on the ascending arch of the colon.

The peritoneum adjoining the wound of the operation was inflamed, and approaching to gangrene; it had not been injured by the knife during the operation. The intestines were unusually large, and distended with flatus. The other abdominal viscera were healthy, but loaded to an extraordinary degree with fat. The ligature had been properly applied to the external iliac artery. The vein was not injured. The surface of the wound and the cellular tissue in the neighbourhood of the artery were sloughy.

The viscera in the thorax were healthy, with the exception of almost general adhesion of the right lung to the costal pleura; and on cutting into that viscus, it was found to be full of dark blood. There was some enlargement of the right limb, but apparently no mortification.

The femoral artery was pervious. The course of the ball was through a bed of fat, fourteen inches in length and three inches in depth, over the pubes, and no muscular substance was injured.

The blood in the aneurismal sac was firmly coagulated, and there was no mark of recent oozing from the injured artery.

N.B.—On removing the coagulum from the aneurismal sac, the divided mouth of the artery was exposed in that part of the wound from which the sac had originated.

The ball had passed immediately over and along the course of the artery, for about half an inch before it divided it. It was given off from the fore part of the femoral artery, about half an inch below Poupart's ligament, and passed in the direction of the pubes. Between its origin and division there was not more than an inch of extent. I raised it with the forceps from its attachment in the bottom of the wound, from the part where it was divided, to where it passed through the fascia, down to the femoral artery; and although it was not actually detached, it would not have borne a ligature.

James Allan, M.D.,
Deputy Inspector, Haslar Hospital.

We, having been present at the *post-mortem* examination of the body of the above J. A. S., concur in this report.

John Mortimer, D.I.H.
J. Stewart, (A,) M.D.,
Surgeon, R.N.

Portsmouth, June 3, 1845.

That a vessel of this class should have bled so furiously in the first instance, could not have been anticipated. Having done so, one can so far understand the active pulsation and rapid extension of the tumour. It was, of course, quite impossible in this case to determine whence the blood flowed into the aneurismal cavity. The principal vessel going to the limb might, for what we knew, have been wounded, or some considerable branch, as the epigastric, the external circumflex, the external pudic, or perhaps a considerable common trunk sending off the superficial epigastric, and branches to the inguinal glands, near their origins from the iliac, or common femoral. The division of even a small branch close to the principal vessel, it is well known, pours out blood furiously, as much so, in fact, as if an opening in the coats of the artery itself were, so to say, punched out, corresponding in size to the area of the branch. "The division of an artery of the size of the last referred to (small muscular branches, which spring from most arteries at irregular in-

tervals), at a distance from the source from which it springs, is of little importance. It contracts, and soon ceases to bleed. But when it is divided close to the trunk, blood issues from it, as it would if an opening, equal in size to the calibre of the little branch, were made in the trunk itself." (Quain's Anatomy, 5th Edit. p. 595.) This I have actually experienced in operating on the femoral artery in the groin, as will appear by and by.

"Any of these inguinal branches being cut near their origin, may bleed a patient (already perhaps reduced, as by mercury,) to death." (Engravings of the Arteries by Sir C. Bell, p. 45).

No one will pretend to say that this patient was not in the most imminent danger of losing his life from day to day, nay, from hour to hour. Let us see what Mr. John Bell, one of the best writers, and to this day the highest authority, on the subject, says to it:—

"But the secondary hæmorrhage is still more to be feared, as the hidden danger is always greater than the open danger; for, as I have said, the patient lying easily, even for ten days, is no security that in the end he shall not bleed to death. Every circumstance concurs to lull us into a fatal security. The patient is easy, and tolerably free from pain; there is no fever; there has been no bleeding: even at the first the wound was scarcely stained with blood. On the eighth day, the eschar of the mortified and bruised parts begins to loosen; on the ninth or tenth day, the sloughs begin to fall, and if the partial gangrene has touched the coats of a great artery, the sloughing of these coats leaves a breach in its side; the blood bursts out impetuously, and it is not that the patient may die of a sort of slow bleeding betwixt night and morning, but he dies in a moment." But even without external hæmorrhage, patients have been known to perish in consequence of the sac giving way, and effusion occurring to some extent into the cellular tissue. I had under my care some years ago, a man about sixty, weak and worn out by continued suffering, on account of an aneurism in the right

axilla, of considerable size. The condition of his circulating system, diseased heart, and vessels, precluded any attempt at a cure by ligature of the subclavian. He was suddenly, whilst in bed, attacked by faintness, and a feeling of sinking. Rapid and great swelling was discovered in the side corresponding to the aneurism, and in about an hour and a half he died. On dissection, the sac, dense and well formed, not, as in the case that forms the subject of this paper, soft, ragged, and lacerable, was found to have given way, and there were, at least, a couple of pounds of blood found in mass, or extravasated in the cellular tissue, under the latissimus dorsi, and down to the crest of the ilium.

In the case of Mr. S., some active measure was evidently required, in order to arrest the threatened danger; cold could not here be expected to answer any good purpose: it had, in fact, been tried without the least benefit. Pressure could not be applied between the heart and the open vessel—applied to the tumour, it would have vastly increased the danger. It might, at first, have given rise to a diffusion of the swelling; but if continued, even for some hours, the already discoloured skin would inevitably have perished; and then, instead of two sloughy wounds, ready at any time to burst out, and threatening to form a communication with this bag of blood, we should have had a third superadded. Could not the sac be cut into, if an operation was really the only resource, and unavoidable; and the wounded vessel, whatever it turned out to be, secured by ligature or ligatures? I, for one, knowing well the circumstances, should not, if it had been proposed, have countenanced it by my presence. Patients who have previously lost a great quantity of blood, are often sunk and lost by the sudden effusion of even a very small quantity. Ranby, the old and experienced army surgeon, tells us that he has seen a patient perish from secondary hæmorrhage, having lost not more than 12 ounces of blood: and every surgeon who has witnessed practice must be sensible of the truth of this remark. Many patients have died instantly on bloody collections being opened, and even in situations where

the assistants had it so far in their power to weaken or arrest the flow of blood by pressure on the trunk of the vessel betwixt the opening into it and the heart.

A man, æt. 35, was wounded in the neck with a penknife. The external carotid artery was supposed to be implicated. The common carotid was tied. Everything went on well for about three weeks. The wound healed all to the granulation through which the ligature had protruded; oozing of blood took place from this point, and gradually increased. A "thrombus," the size of a walnut, formed in the neighbourhood of the original wound. This was opened, and a clot turned out; there was a smart gush of blood, and death immediately ensued.

Two young men were "larking" in an agency office; one of them drew a sabre, and struck his companion, by an awkward and unintentional thrust, on the inside of the thigh. There was a sudden and most profuse gush of florid blood, showing that a large vessel had been opened. The patient was saved for the time by syncope supervening. The thigh was bandaged up; next day, an apothecary, assisted by a mere anatomist, not a very practical one, proceeded to look for and tie the wounded artery. The thigh was much swollen; a large collection of blood having filled the subfascial cellular tissue. This bag of blood was cut into. The operator and his attendants were instantly covered with its contents. The lad was dead. The danger of opening a false aneurism, with the view of searching for the wounded vessel, must, of course, be very much enhanced, when the tumour is so placed that there is no possibility whatever of making pressure on the trunk of the artery on the proximal side of the opening into it, or of the origin of any branch wounded close to where it is given off.

In the case of Mr. S., the principle of tying the artery, where wounded, could not possibly be carried out with any propriety. It was not known what vessel was really implicated, and this could not be known during life. If the tumour had been lower down, somewhere in the thigh, the question

of cutting into the sac might have been entertained; but even then, it is to be doubted whether or not the patient, in his reduced state, would not have had as good a chance by the ligature of the iliac as by the tying of the femoral, or any of its branches where divided.

As it was, the cyst could not have been opened without great loss of blood, however dexterously and boldly it might have been set about. Even knowing, as we do now, from whence the blood came, it was not likely that the application of a ligature to the branch would have permanently arrested the bleeding. Indeed, it is distinctly stated by Dr. Allan that the vessel would not have held a ligature. It was not unlikely that, even in the first instance, or, perhaps, at a later period, and in consequence of secondary bleeding, it might have been necessary to tie the common femoral. Secondary bleeding from this artery, supposing that the patient yet survived, would, probably enough, have supervened. If we look at the circumstances in which this vessel is placed, the doubt as to its length and the arrangement of its branches, we cannot be over sanguine as to its permanent closure. By experience it is well ascertained that, when exposed and tied, it has very often been the source of alarming secondary hæmorrhage. After all, the ligature of the iliac was more than likely to be required in the end, always supposing that a patient so treated lived through all his various trials.

This mode of proceeding in the particular case, was thus looked upon as in every way perilous and inadvisable. The placing of a ligature upon the external iliac, so as to favour the coagulation of the contents of the tumour and the permanent closure of the wounded vessel, seemed to afford the only chance of safety. It may be asked, Is there any thing to bear a surgeon out in adopting this practice? Can any cases be brought forward to show that vessels bleeding outwardly, or pouring their contents into the tissues of a limb or region, have ever been put in a way of being permanently closed, in consequence of the flow of blood being intercepted and weakened for a time, by the application of a ligature

upon the principal arterial trunk? First of all, then, let us look to what happens, in some of those exceedingly perplexing cases of wounds in the palm of the hand, followed by secondary hæmorrhage, or false aneurism. The great difficulty of securing those vessels, even in recent solutions of continuity, is acknowledged. But when, perhaps at the end of eight or ten days, blood bursts out furiously from the wound from time to time, the young surgeon is often puzzled what to do. The bleeding has sometimes been stopped by well-applied pressure; the wound being, perhaps, somewhat enlarged, the clots cleared out, and compresses applied accurately to the bottom of the cavity. Sometimes, again, the bleeding has seemed rather to be provoked by compression and by tight bandaging. It has ceased when the hand has been freed from all apparatus, the wound perhaps dilated, and cold applied. Cases of this kind used to be related by Mr. Abernethy, in his Surgical Lectures. The bleeding, it is true, may often be arrested for a time by tight binding; but the process for the permanent closure of the wounded vessel cannot be expected to go on favourably, if at all, under such a degree of pressure as is required to stay the flow. Under many circumstances, as when the member is violently inflamed and swollen, and the tissues infiltrated with blood, with serosity and purulent secretion, pressure cannot be borne, and may be followed by the most disastrous consequences. What is then to be done? The ligature of the radial and ulnar arteries, separately or together, near the wrist, will seldom serve any good end. This practice has been many times tried, and failed in a most marked manner. The ligature of the brachial and light dressing of the wound has been found to answer admirably in such cases.

Thomas Sutherland was admitted into the Royal Infirmary, Edinburgh, January 6, 1827, on account of a wound by a piece of a broken wine bottle. The radial artery was implicated where it passes betwixt the metacarpal bones of the thumb and forefinger, to join the deep palmar arch. The vessel was tied on the proximal side of the opening, and it

being found impossible to discover the other end, a piece of sponge was introduced into the wound. On the 11th, bleeding occurred from the part of the vessel which had been tied. The wound was enlarged, and the artery tied above and below. The original wound then took to bleeding. It bled repeatedly, on the 14th, and again on the 15th. The hand had become swollen, and a quantity of matter had collected. An attempt was made, by cutting up the original wound, to expose and tie the bleeding vessel; but on account of the sloughy state of the parts the ligature would not keep its hold. The humeral was then tied by Sir George Ballingall, and there was no further trouble; the patient made a rapid recovery.

A man had his thumb all but blown away by the explosion of an old powder-flask made of copper. He lost but little blood at the time. He was admitted into the University College Hospital, whilst Mr. Potter held the office of house-surgeon, some days after the infliction of the injury, with his hand violently inflamed and swollen. There was a deep ragged laceration between the thumb and forefinger, which seemed to extend to the carpal end of the first metacarpal bone. The wound was covered with foul and fetid sloughs, and all around was blackened. There was another and more extensive laceration, but superficial, extending from near the middle of the palm, round the root of the forefinger to the dorsum of the hand. There was a great deal of constitutional disturbance. All seemed to promise well. After a few days the fever abated, and the wound became clean and began to granulate. Ten days after the patient's admission, however, an alarming arterial bleeding took place, to the extent of sixteen or eighteen ounces. This happened on the 23rd of the month. On the 27th, the patient was seized with sudden and intense pain in the injured part, and on exposing it, a pulsating tumour, round and elastic, was discovered, betwixt the metacarpal bone of the thumb and that of the forefinger. The pulsation was abated and the pain relieved by pressure on the radial. I considered it, however, more safe

and certain to put a ligature on the brachial at once, than upon this vessel. The pulsation ceased instantly and entirely, and the pain was relieved. The ulcer bled freely during the operation, but the bleeding was immediately arrested upon the ligature being tied, and all ended most satisfactorily.

William Grant was admitted into the Royal Infirmary of Edinburgh on the 4th of May 1827, on account of gun-shot wound of the hand, injuring the ball of the thumb and the parts on the posterior surface of the metacarpus. A profuse hæmorrhage occurred on the 15th, from the radial artery, where it passes betwen the metacarpal bones of the thumb and forefinger. This hæmorrhage recurred, in spite of every effort to restrain it. The brachial artery was tied by my late colleague, Dr. John Campbell. On the 17th day after the vessel was tied, profuse bleeding occurred from the wound in the upper arm, made in the operation, as was supposed from the premature disturbance of the ligature, by a sudden start of the patient during his sleep. Another ligature was passed under the artery about two inches above the former, and from this time the cure was progressive. There was no return of bleeding from the wound of the hand.

John Carter was brought to the University College Hospital, April 10th, with his hand shattered by the bursting of a gun; the little finger was removed, and parts of the ring and second fingers. Besides the injury to the fingers, there was a lacerated wound of the palm, extending from the cleft between the middle and ring fingers, two-thirds across the palm. The wound was not deep: the palmar fascia not appearing to be much injured, the edges of the wound were brought together by a single suture and simply dressed. The progress of the wound was rapid, till on the 10th day (April 21st), when the wound of the palm had filled up and was beginning to cicatrize, a pulsating tumour, about the size and shape of an almond, and extending across the wound, was perceived at its upper part: the pulsation was stronger than the pulse at the wrist, and superficial, and the long diameter was in the direction of the wound. Pressure on the

ulnar artery almost entirely controlled the pulsation; pressure on the radial had very slight effect on it, but pressure on both together, or on the brachial, entirely commanded it. The palm of the hand was padded with lint, and the limb being bandaged, two ring tourniquets were applied to the humeral artery, the one being tightened when the patient complained of pain from the pressure of the other: an interval was left in the bandages opposite the tumour, to enable the surgeon to acquaint himself with the state of the pulsation. After a day or two the alternate tightening of the tourniquets was left to the patient.

May 14.—The fingers, notwithstanding the pressure on the artery, are healing fast; the tourniquets have throughout well controlled the pulsation in the aneurism; to-day, on removing them, scarcely any pulsation was perceptible in it.

18th.—To-day, on removing the pressure from the artery, no pulsation could be perceived in the tumour, but the beating returned feebly when it had been off a little time. The tourniquets were kept on till the 29th, when, on removing them, no pulsation was felt in the aneurism; the circulation in the brachial was fully re-established on taking off pressure. The pulsation, however, returned feebly in a few hours, and in three days was nearly as strong as ever. The patient had got tired, by this time, of the pressure, and would not keep it up sufficiently. On June the 8th, Mr. Liston tied the brachial artery, which immediately stopped the aneurismal pulsation and that of the radial and ulnar arteries. No pulsation has been (June 30th) perceived in the site of the tumour since the operation, though the pulsation has returned pretty fully in the arteries of the forearm and hand; the wound soon healed, with the exception of the part close to the ligature, which has not yet come away. The ligature separated a few days after the last report. The wound healed speedily, and the patient left the hospital quite well.

Mr. Guthrie, in cases such as those above related, recommends that a clean and decided incision should be made in the line of the wound down to the metacarpal bone, and that

this should, if necessary, be cut out with the finger, so as to obtain space to see the wounded vessel. "The hand is only to be amputated as a last resource."

The practice of tying the brachial artery, on account of secondary hæmorrhage, or false aneurism in the palm of the hand, though ascertained to answer perfectly in many instances, cannot be expected to be uniformly successful. I am quite ready to admit, that "the ligature of an artery at a distance from a wound in its coats, will not always secure the patient from hæmorrhage; for the blood will either flow from the lower end of the artery, or from the upper, into which it will enter, through branches which open into the trunk between the ligature and the wound." In the neck and forearm, the arterial trunks of which communicate so freely by the circles and arches, it might, *à priori*, be supposed very likely to fail; and so it is found to be the case in practice.

Mr. Hodgson, in his excellent work on "Diseases of Arteries and Veins," relates a case furnished him by the late Mr. Earle, in which, after ligature of the brachial, hæmorrhage occurred from the sac of a false aneurism of the radial, and it was ultimately necessary to tie this vessel also.

A case, in many respects similar, occurred in my practice many years ago, in which the ulnar artery had been wounded in the upper part of the forearm by a small chisel. A circumscribed false aneurism of small size, which had formed, was compressed along with the lower part of the limb, whilst pressure was also made in the course of the brachial; but the surface of the tumour soon became abraded, and the cicatrix threatened to give way. The brachial artery was tied. About 12 days afterwards, profuse bleeding took place from the original wound, a small slough having separated; and then the practice which probably should have been at first followed, was successfully adopted. An incision was made along the course of the ulnar artery, through the bleeding wound, and both ends of the bleeding vessel tied. A cure soon followed.

Again, in secondary hæmorrhage from stumps, that bleeding which takes place about the 8th or 10th day, or even as

late as from the 20th to the 30th, in consequence of an unhealthy condition of the wound, induced by an unfavourable state of the atmosphere, the exposure of the patient to various vapours and miasms, or from too free indulgence in stimulating food and liquors, the surgeon is called upon to afford prompt assistance. When the bleeding occurs at an early period, say within a few days of the amputation, the opening up of the wound, the turning out of the coagulated blood, gentle support, and elevation of the stump, with the constant application of cold, may have the desired effect; but these means often fail, and these are cases in which there can be but little use in attempting to find and tie the opened vessels. Surgeons are pretty well agreed, I am led to believe, that the ligature of the trunk supplying the limb, and above any branches that may possibly reach the stump, is the proper practice to be pursued. I have had occasion to perform this operation pretty often, principally on hospital patients, and with uniform success. In what, then, do these cases differ from false aneurism, fed by a vessel large or small, as may be? In the one case the blood is confined for a time in a tender bag, ready to burst out sooner or later. In the other, the blood is poured out without restraint, on every hæmorrhagic effort, whenever the vessels get full and the circulation is any how excited. There is no recurrent circulation, it is true; but we may have bleeding from several open mouths at one and the same time, and the trunk of the vessel below the deligated point is, of course, freely supplied through the anastomosing branches.

A case is recorded in the Society's Transactions, by Mr. Potter, which bears somewhat on the question at issue. The patient had amputation of the thigh performed on account of a diseased leg (intractable ulceration, with solid œdema), which had long been a burden to him. On the 8th day, bleeding commenced from the stump; on the 9th, the common femoral was exposed and tied, immediately before the ligament of Poupart. It was in this instance that a small artery was wounded, close to the trunk, and so impetuous and rapid

was the bleeding, that it covered the by-standers, and induced most of them to believe that the trunk itself had been cut into. The branch was secured, and the operation proceeded with. On the 14th day, the ligature separated from the trunk of the vessel. Sixteen days afterwards, bleeding took place from the wound in the groin, and the external iliac was forthwith tied successfully.

A very interesting case, treated with great judgment and skill by my friend Dr. Paul, of Elgin, may also be added here. The patient, a young man, had his thigh amputated secondarily, in consequence of bad compound fracture of the bones of the leg, extensive suppuration, and hæmorrhage, on the 9th of August 1842. On the 15th of the same month, alarming bleeding took place from the stump. The common femoral was cut down upon and tied. On the 30th, bleeding took place from the deligated part of this vessel and recurred on the next day. The external iliac was then tied. There was no further hæmorrhage, and the patient ultimately recovered.

A few cases may be added in which secondary hæmorrhage followed wounds and ulcerations of arterial trunks and branches, and others in which false aneurisms formed, and where the practice of securing the trunk at some distance by impeding for a time the flow of blood to the part, gave opportunity for the curative process of nature to close the wounded vessel permanently, so that the lives of the patients were thus preserved.

H. S., ætat. 14, was admitted into the University College Hospital on account of a wound of the back of the leg, caused by falling through a skylight, which he was engaged in cleaning. The gastrocnemius, soleus, and flexor communis digitorum were divided, and it was thought improbable that the posterior tibial artery should have escaped. He lost, it was said, about two quarts of blood. Two large vessels were tied, the wound was dressed, and went on favourably; but on the 13th a profuse hæmorrhage occurred, "evidently from the posterior tibial artery," and was arrested

by pressure after 14 ounces had been lost. Again, on the 15th, the wound bled more furiously than before; the artery was cut down upon and tied. On the 25th, another hæmorrhage occurred to 12 ounces: and again, on the 26th, the same quantity was lost. The wound was then extended upwards, and the posterior tibial artery again secured. Still, on the 27th, bleeding took place, apparently from the lower part of the wound. Mr. Cooper then tied the popliteal, with the effect of permanently arresting the bleeding, and the patient made a good, though slow, recovery.

In the year 1814, my colleague, Mr. Cooper, tied the superficial femoral, on account of profuse hæmorrhage from a gun-shot wound in the popliteal space, ten days after its infliction, and deposition of lymph in the vessel at the wounded part. "But no doubt it was the diminution of the impulse of the circulation by the ligature of the femoral artery, which enabled nature to complete the obliteration of the wounded part of the vessel."

A Student of Medicine, ætat. 24, had suffered from eruptions on his legs, whilst pursuing his studies closely in the dissecting-room, and at the time a good deal out of health. He thought that he had scratched the affected part of the right leg, which itched much near the ankle, and introduced into it some cadaveric poison. The lymphatics of the limb and the glands in the corresponding groin became inflamed, and swelled much. Matter formed, and I opened, after a time, an abscess about four inches above the knee, and over the vastus internus muscle. A fortnight after this, the pus having been occasionally slightly tinged with blood, arterial hæmorrhage took place suddenly to the extent of two pints, whilst the patient was on the night-chair. Pressure was made on the femoral; syncope took place, and the bleeding ceased. Two other bleedings occurred, and the patient became so much exhausted that any further loss of blood could not have been borne without risk of sudden death. The superficial femoral was secured at the usual place: and the ligature separated on the 19th day. There was no further bleeding:

—recovery was slow; but the patient now enjoys perfect health.

About the 12th Sept. 1827, some carcinomatous glands were removed from a chimney-sweeper's groin—not a very wise or warrantable proceeding. The wound looked tolerably well for some time, but it soon changed its character. On the 18th December, after degeneration of the sore, and extension, both in width and depth, had taken place, the discharge having been thin, and a good deal tinged with blood, alarming hæmorrhage occurred: this returned several times during the day. The external iliac was with some difficulty, owing to the condensation of the tissues about the groin, exposed, and included in a ligature. This came away on the 11th day, and on the 30th January the wound was nearly healed. Bleeding, however, occurred from it, on the patient trying to get out of bed. This recurred more than once, and the blood was supposed to proceed from the obturator, opened from an extension of the malignant ulceration. Its flow was arrested by pressure with sponge. He was received into a workhouse, and lived six months.

The external iliac was obliterated, and its coats converted into a ligamentous cord, from the point at which it had been tied, immediately above the origin of the epigastric, up to its junction with the internal iliac. On examining the ulcer, there was no trace of the common femoral artery for fully three inches, including the origin of the profunda; and the ulcerated extremities were closed by firm coagula. The formation of these coagula, no doubt, was attributable to the force of the circulation being diminished by the obliteration of the vessel above. The removal of the glands was undertaken by a practitioner long since dead. The chimney-sweeper's life, no doubt, was much prolonged by the ligature of the iliac, performed by my friend Sir George Ballingall. It was a distressing case to be concerned in; but under the circumstances, there was no other course to be pursued.

The late Dr. Hennen, in his excellent work on military

surgery, relates a very interesting case, in which, through sloughing bubo of the groin, the external pudic was supposed to have been opened: most profuse bleeding took place; it recurred in spite of pressure, actual cautery, &c. &c. The femoral artery itself was, it is said, found, on a close examination, after removal of the clots, to have given way. The external iliac was tied, no further bleeding took place, mortification set in, the limb was amputated pretty high up; but the patient recovered.

Other cases of the kind might, I have no doubt, be discovered, and brought forward, in corroboration of the propriety of this line of practice.

In the 7th vol. of the Transactions of this Society, Mr. Collier relates a case of false aneurism of the groin following a wound of the femoral, or some branch of that vessel, by a musket-ball. There was considerable bleeding at the time of the wound, but it healed without any thing remarkable taking place. "Fearing lest the pulsation, or any loss of health, might occasion the cicatrix to ulcerate, Mr. C. determined not to delay securing the external iliac artery, an operation which he judged to be requisite in order to save life, and to be urgently called for from the visible enlargement of the tumour." The patient died from mortification of the limb, and, on dissection, "a small communication was found between the femoral artery and vein, at the side of the tumour, about an inch and a half below the origin of the profunda."

In the 11th vol. of the same Transactions, Mr. Norman, of Bath, has given some exceedingly interesting cases of aneurism, in which the external iliac and femoral were tied. One of them bears on the subject in hand.

A boy of 14 years was admitted into the hospital on the 28th August 1817. A month before, he had received a punctured wound in the upper and outer part of the thigh, from which he almost bled to death. Blood was discharged for two days, but not to such an extent as to excite alarm. On the third day it bled again, and this was repeated several

times. By and by all hæmorrhage ceased for more than ten days. Exactly a month from the date of the injury, a very profuse bleeding took place, which reduced the poor boy very much: and on the following morning, an attempt was made to secure the wounded vessel. An incision of seven inches was made through the wounded part on the outside of the limb, a large cavity amongst the muscles was opened, and the coagulum turned out from the bottom of it; the blood issued out furiously and abundantly, but the bleeding vessel could nowhere be discovered. Mr. Norman, unwilling to hazard any further loss of blood in attempts to search for the wounded part of the vessel, tied the external iliac, the vessel being meanwhile compressed by an assistant's fingers in the wound. The hæmorrhage was moderated, but not entirely checked. A second ligature was passed round the femoral artery, two inches below Poupart's ligament, and this had the desired effect of stopping the flow of blood entirely; only 4 ounces were lost, yet the boy was so exhausted that his extremities were cold, and no pulse could be felt; his breathing being almost suspended. Mortification of the foot took place, but the patient eventually recovered, and left the hospital at the end of November.

Mr. Norman is of opinion that the blood which flowed after the application of the first ligature, reached the femoral by the epigastric and circumflexa ilii, and that the original wound was below the point at which the second ligature was placed. In the catalogue of the Museum of University College, are notices of two cases in point.

" *The external iliac artery tied for ulceration of a great portion of the femoral artery.*

" Josiah Wilcock, a young seaman aged 22, was admitted on board the Hospital Ship "Grampus," with a bubo in the left groin. When he had been in the hospital three weeks, his general health became much affected, and there was violent inflammation of the bubo. The inflammation became extensive, and deep sinuses formed in various directions, particularly

among the abdominal muscles, and in the course of the femoral artery in the thigh. After 15 weeks of great suffering, the ulceration assumed a phagedenic character. In the course of one day, a pulsating tumour, of the size of a pigeon's egg, formed, an inch beneath Poupart's ligament over the situation of the artery. Next day the tumour burst, and before I could reach him he had lost about two pints of arterial blood. I immediately tied the external iliac artery, which was rendered somewhat formidable, from the mass of disease existing in that portion of the abdominal muscles through which I had to make my incision. On the tenth day the ligature came away. The discharge from the wound till within three days from his death was quite healthy. The foot and knee mortified, and he died on the twentieth day from the operation.

"JAMES THORBURN, Assistant Surgeon."

" *The external iliac artery tied.*

"An old woman had a swelling in the groin, which was opened by a lancet, and hæmorrhage to an alarming degree immediately took place. Compression of the artery at the groin being made, the hæmorrhage ceased. When the surgeon arrived, he found that florid blood flowed copiously from the puncture whenever the assistant's finger was raised from the artery of the groin, and was completely restrained when the artery was compressed. He tied the external iliac artery, and there was no more bleeding. The ligature came away at the proper period. The outward wound did not heal—sinuses formed around it. In about three weeks the patient died of peritonitis. Upon injecting from the abdominal aorta, the wax filled the femoral artery, and its branches below where the ligature was applied. It would appear from examining the preparation, that the hæmorrhage was owing to one of the branches of the femoral artery being opened either by the lancet, or its coats destroyed by the peculiar nature of the tumour."—*Descriptive Catalogue of the Museum of Anatomy of University College, London,* page 149 and 150.

In conclusion, I must beg leave to refer to one more case. It is to be found in the works of a well-known army surgeon. A man 30 years of age, was wounded on the glorious 18th of June, by a musket-ball, which entered the left groin a little below Poupart's ligament, and passed through the inside of the thigh.

"On the 29th, (mark, the 10th day from the injury,) the slough from the anterior wound came away, and was followed by so frightful a hæmorrhage as to leave no doubt whence it proceeded, nor (from the wound being so high up) any alternative as to the means to be adopted for stopping it."

The external iliac was tied, but the patient died of fever on July 5th : there is, however, no account given of any dissection of the parts.

"In this case the necessity of the operation is evident, and as far as it went, also, its success. Not a drop of blood was lost after it."—So says Mr. Guthrie, who, it is to be presumed, conducted the treatment of the patient. We are here left to conjecture what vessel was really wounded. It is said "that there could be no doubt as to whence the hæmorrhage proceeded;" but it may have been from a branch, as likely as from the trunk, and those who have attended to the description of the hæmorrhage in the case of Mr. S., to its impetuosity, and amount, will bear me out in this assertion. The external pudic, or external epigastric, or one of the circumflex arteries, may have been here cut off close to their origin, just as likely as that the femoral was wounded.

I have thus endeavoured to show—

1st. That the case of Mr. S. was one of great and immediate danger.

2ndly. That some decisive step required to be taken, and that without a day's delay, in order to avert the danger that impended over him.

3rdly. That very great risk would have been incurred in searching for and attempting to put a ligature upon the wounded part of the vessel.

4thly. That there is ample authority for adopting the

step which was had recourse to in the case. Ligature of the external iliac was undertaken, in order to ward off the expected fatal termination, through a sudden escape of arterial blood.

And it may here be remarked, that we were not apprehensive of a remote danger, or labouring under a vague impression that something untoward might arise; the danger was manifest. An artery had begun to pour out its contents impetuously, and the blood was only prevented from escaping externally by rotten tissues, that were about to separate, and could not by any possibility resist the impulse many hours longer. It must also be borne in mind, in considering the bearings of this case, that it might have been absolutely impossible to effect even the operation of tying the iliac, had the effusion extended ever so little further. No one will pretend to say that the operation of tying the iliac artery of itself is not attended with danger to life. But the dangers of mortification, secondary bleeding, &c., likely to arise from the operation, were considered as weighing but lightly in the scale against those impending from the effects of the pistol-shot. Mr. S. died, it has been seen, from the effects of inflammation of the peritoneal cavity. But this was scarcely taken into account at all, in consulting on the case. When we look at the result of the cases published in this country, from the time that Mr. Abernethy first tied the vessel, about fifty years ago, to the present period, it will be seen that we were justified in not laying very great stress on this source of danger. It appears that out of 45 cases recorded, (and collected by Mr. Crisp, in an excellent paper on aneurism, to which was lately awarded the Jacksonian prize by the Council of the College of Surgeons,) 9, or $\frac{1}{5}$th, died; three of those from sloughing and bursting of the sac, two from mortification of the limb, two from secondary hæmorrhage, one from disease of the chest, and one from sinking of the vital powers. Many unsuccessful cases have no doubt been left unpublished, and some in which the patients suffered from inflammation of the peritoneal membrane might be adduced.

In the case of Mr. S., the sac no doubt might have sloughed, secondary bleeding might have occurred on the separation of the ligature, however carefully applied. But there was nothing to prevent the collateral circulation from being carried on freely, and nothing connected with the wound, or consequent aneurismal swelling, to prevent the free return of blood by the veins. In the opinion of those concerned, the step most likely to avert danger, and prolong the patient's life, was adopted; the only step, it has been shown, that could have possibly been resorted to with propriety or safety.

A CASE IN WHICH

A LARGE TUMOUR

WAS DEVELOPED IN THE SUBSTANCE OF THE

FIFTH NERVE AND ITS GANGLION.

By JAMES DIXON, Esq.,

SURGEON TO THE ROYAL LONDON OPHTHALMIC HOSPITAL.

Received May 2nd—Read June 23rd, 1846.

I HAVE lately examined the brain of a woman whose case was published in the last volume of the Transactions of this Society. Before detailing the morbid changes which were found after death, I may be permitted to notice briefly the leading symptoms of her disease.

The patient, aged 59, came under my care, in October 1844, for dimness of sight in the left eye; and, in the course of my inquiries, I ascertained that the fifth nerve on that side had totally lost both its sensitive and motory function for a period of six months. Towards the middle of December, inflammation of the eye came on; the anterior chamber was filled with lymph, which blocked up the pupil, and glued the edge of the iris to the lens. About the same time, violent pain attacked the parts supplied by the fifth nerve, which still remained insensible to outward impressions.

In August 1845, this total anæsthesia continued; the external rectus and levator palpebræ, as well as those muscles supplied by the facial nerve, had become paralysed. There was total deafness of the left ear. The patient had frequent attacks of giddiness and loss of memory. Pain was no longer felt in the branches of the fifth nerve, but was referred to the inside of the skull. She died on the 8th of February 1846.

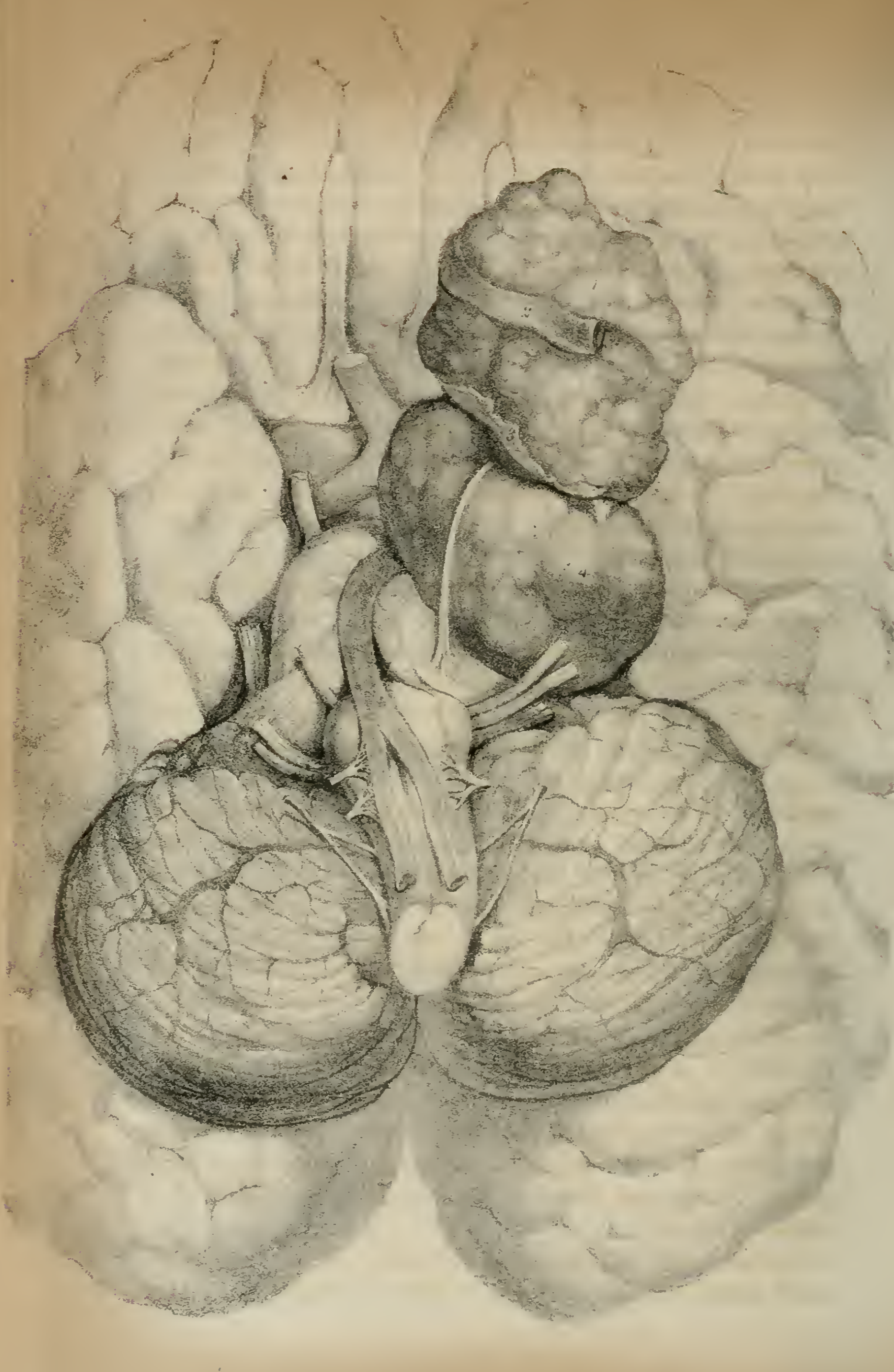
I am indebted to Mr. Warder, of Brompton, for the opportunity of making the *post-mortem* examination.

On the removal of the scalp, a striking difference between the two temporal muscles was observed. That on the right side was of natural appearance, whilst the left one was so wasted, as hardly to be recognized. Some pale fibres, scarcely more developed than those of a healthy bladder, were interposed, as a thin layer, between the temporal fascia and the bone.

When the anterior lobes of the cerebrum were raised, the olfactory nerves were seen, perfectly alike in size and general appearance.* Everything was healthy in the brain and nerves on the right side. To the left of the pons Varolii was a rounded mass, about the size of a large walnut, which encroached upon the median plane, and had thrust the pituitary body to the right side. Over the upper surface of this tumour ran the fourth nerve. Another tumour was seen, extending from the upper edge of the petrous portion of the temporal bone to the foramen lacerum orbitale, and covered by dura mater, which it had lifted up from the middle fossa of the skull. When this fibrous covering had been removed, the two tumours were found to be continuous, and to form but one mass, constricted by the dura mater. The front part of the morbid growth extended to the foramen lacerum orbitale, but did not enter the orbit; externally, it reached about three quarters of an inch beyond the foramen ovale in the sphenoid bone; internally, it had pressed against the sella turcica, and had caused the left half of it to be absorbed; but it had not interfered with the optic nerves, which were of normal bulk and colour at their entrance into the optic foramina. The third nerve and the cavernous sinus were brought near to the median plane.

The tumour was drawn away from the foramen lacerum orbitale, and turned backwards, by cutting through the three divisions of the fifth nerve, where they emerged from it. The tumour had hollowed out for itself, in the concavity of the

* Smell had, during life, been completely lost in the left nostril.



on Stone by W. H. Kearney

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great wing of the sphenoid bone, several rounded pits, which were lined throughout by dura mater. The osseous structure was laid bare only near the apex of the petrous portion of the temporal bone, where the roof of the carotid canal had been absorbed. The internal carotid artery was here in contact with the under surface of the tumour, and was lodged in a groove in its substance. A small process of the tumour had also penetrated through a breach in the bone into the internal ear, and thus the deafness and facial palsy were accounted for; although the facial and auditory nerves were quite unchanged at their entrance into the internal auditory foramen. When the brain had been completely removed from the skull, the sixth nerve was seen lying along the under surface of the tumour.

The glosso-pharyngeal, vagus, spinal-accessory, and lingual nerves, were unaltered.

An accurate examination of the morbid growth showed it to be a degeneration of the trunk of the fifth nerve and Casserian ganglion. The original boundary between these structures was marked out by that portion of dura mater which, in the drawing, is seen still encircling and constricting the tumour. It is a dilatation of the sheath into which the fifth nerve enters before it spreads out into the ganglion. The tumour was attached to the encephalon only at the junction of the pons Varolii and crus cerebelli, and this attachment was so slight, that it gave way under the least force. The tumour lay in a hollow, formed at the expense of the left half of the pons; and the basilar artery, in consequence, presented a considerable curvature towards the right side.—(See Plate VI.) A few delicate vessels ran from the pia mater of the pons Varolii, crus cerebelli, and middle lobe of the cerebrum, and were lost in the tumour. A section carried through it, showed a reddish, soft, but not pulpy mass, with portions here and there of firmer consistence, and of a yellowish colour.

Various parts of the tumour, viewed under the microscope, presented one uniform structure, namely, a mass of

cells, (oval when isolated, but more elongated when seen in a cluster,) intermixed with areolar tissue and blood-vessels. Not a trace of nerve-tubes, or ganglionic corpuscles, could be found; but in a piece of the third division of the nerve, which was cut out of the foramen ovale, the nerve-tubes were distinctly visible among the cells of the tumour.

Nothing abnormal was noticed in the motory nerves, muscles, or other contents of the orbit. The ophthalmic ganglion was small, but not less than we often find it in healthy subjects; and it presented distinct ganglionic corpuscles under the microscope. The ciliary nerves were unchanged in their appearance, and the accompanying veins unusually small and bloodless. The globe of the eye was as large as the right one. The sclerotic was of natural thickness; the choroid of a reddish brown, with no trace of black pigment, except a little about the ciliary processes. The vitreous humour was perfectly clear and colourless; the lens of a pale yellow, opaque at the centre, but very slightly so towards the circumference. The iris adhered to the middle of the lens, and had the homogeneous, non-fibrous appearance which follows iritis. The hinder surface was quite black with pigment. The cornea, towards its lower part, showed slight traces of its former opacity.

It would be absurd, from a single case like the present, to generalize upon the influence of different nerves in nutrition; but it will be observed that there was here no atrophy of the eye-ball, although the Casserian ganglion, and the whole trunk of the fifth nerve between that body and the brain, had been replaced by an adventitious growth.

It may be objected by some, that the amount of influence which disease of the fifth nerve has over inflammation of the eye was rendered less appreciable, in this patient's case, on account of the pressure of the tumour upon the cavernous sinus, which might be considered sufficient to produce the various phenomena of inflammation, by impeding the return of blood from the organ. To meet this objection, I may advert to the case of a man who died a few days ago in St.

Thomas's Hospital, under the care of Dr. Burton. Entire loss of function of the fifth nerve on the right side had been followed by an ulcerative inflammation of the cornea, precisely similar in its character to that which has just been described. A hard nodule of yellowish matter, about the size of a large pea, was found in the substance of the fifth nerve, close to its origin from the pons Varolii; but the cavernous sinus and all the nerves in its neighbourhood were perfectly free from disease.

Other symptoms, observed during life, were satisfactorily explained by the *post-mortem* examination. There had been total amaurosis and immobility of the left eye, and, on exposing the third nerve on that side, a nodule of yellow colour and gristly hardness, like that in the fifth, was found developed in its substance. This mass had pressed upon the optic nerve just behind the commissure. The fourth nerve was similarly compressed; and the sixth, diminished to half its natural thickness, had become adherent to another deposit of yellow matter which was seated upon the basilar artery, just anterior to the junction of the two vertebrals.

No difference could be perceived between the deeper textures of the two eyes. In each the choroid was of a rust-brown, with a little black pigment about the ciliary processes, the retina looked healthy, and the vitreous body was perfectly colourless and clear. The left lens was transparent, and of a pale straw colour; the right one had the same tint, but was slightly cloudy. The lower third of the right cornea presented a dense white cicatrix, to which the under edge of the pupil adhered. Sufficient opening, however, was left for the purposes of vision; and, as this optic nerve was unaffected, the patient had latterly been able to distinguish large objects.

EXPLANATION OF PLATE VI.

1.—Tumour developed in the trunk of the fifth nerve.

2.—A similar mass replacing the Casserian ganglion.

3.—A ring-shaped portion of the canal of dura mater through which the fifth nerve passes before spreading out into the ganglion. The canal is much dilated by the growth of the tumour, and the latter has acquired a constricted form.

4.—The sixth nerve, almost torn from its origin by the pressure of the tumour above it.

5.—The internal carotid artery lying in a groove on the under surface of the morbid mass; the roof of the carotid canal in the temporal bone having been absorbed.

ON THE

CAPACITY OF THE LUNGS,

AND ON THE

RESPIRATORY FUNCTIONS,

WITH A VIEW OF ESTABLISHING A PRECISE AND EASY METHOD OF DETECTING DISEASE BY THE SPIROMETER.

By JOHN HUTCHINSON, Surgeon.

Communicated by GEORGE CURSHAM, M.D.,

ONE OF THE SECRETARIES OF THE SOCIETY.

Received January 22nd—Read April 28th, 1846.

1. The subject which I have the honour to bring before this Society, is the consideration of the functions of the organs of respiration, with reference both to health and disease, as deduced from the result of an extensive research.

Before commencing this investigation, it is advisable to ascertain what has been already done by others upon the same subject, in order that the observer may be directed to the points which most require examination, and be enabled to render more apparent the results of his own experiments.

To understand the mechanism and function of the thorax and its contents, demands essentially a knowledge of the circulation of the blood, the composition and pressure of the atmosphere. These subjects were so unknown to the ancients, that we are not surprised to find from their writings how little accurate knowledge they possessed respecting the functions of the respiratory organs.

It is no less curious than instructive to observe, that while their writings teem with refined and absurd hypotheses, how tenacious they were of yielding to the truth when light first began to glimmer upon the subject.

2.—Hippocrates treats largely upon air, water, and situation. Air he reckons as one of the aliments of life; but it was more generally the opinion of the ancients, that a kind of "*vital fire*" was kept up in the heart, and that the blood was tempered in the lungs. Nothing deserving of notice touching the respiratory functions is to be found in the writings of the Greek philosophers. Plato, in his Timeus, says that the "Genii placed the lungs in the neighbourhood of the heart, to keep it cool and in exact obedience."*

Galen, also, considered the chief use of the lungs was to carry off vapours equivalent to smoke from a fire.†

The philosophers of subsequent periods disputed greatly on the subject, and accounted for our well-being as dependent upon fermentations, operations of active spirituous and ethereal particles, as a vital spirit passing from the lungs to the heart and arteries, and becoming animal spirits, which were by this means generated from the air. Others considered the "*vital principle*" a saline vapour, a hot, inflammable, sulphureous spirit, a volatile acid salt; an acrid acid, which preserves the blood in density; and that another use of the lungs was to "*alternate,*" or condense, or attenuate, or cool, or heat, or mix, or purify the blood, or shape the blood-globules, or to give configuration to the "finer humours." Others set these views altogether aside, considering that the only use of the lungs was to keep the heart in motion. Such notions prevailed in the time of Descartes, Bertier, Van Helmont, Stevenson, Malpighius, Lister, Vieussenius, Bryan Robinson, Lower, Whytt, Crooke, &c.‡ Galen appears to have held some correct views on the movements of the chest and lungs, viz., that the thorax, distending, draws in the air, and that the lungs follow the dilatations of the chest; this he proves by a direct experiment upon a dog.§ Nevertheless, for 1500 years

* Thomson's Anim. Chem. 1843, p. 604.

† Haller, vol. iii. p. 354.

‡ Haller's Phys. vol. iii. p. 313 *et seq.* Crooke's Anatomical Description of the Body of Man, 4to, 1651, p. 285.

§ Crooke, Op. cit. p. 282.

afterwards, this truth is disputed, and even then not generally believed; so that from Galen to Robert Boyle, naturalists, physicians, and philosophers, explained the simple operation of breathing in three ways:—

First,—"That by the dilatations of the chest, the contiguous air is thrust away, and that, pressing upon the next air to it, and so onwards, the propulsion is continued till the air is '*driven* into the lungs' and so dilates them."

Second,—That the chest is like to a pair of common bellows, "which becomes to be filled because it is dilated."

Third,—"That they are like a bladder, which is therefore dilated because it is filled."

Boyle, the greatest philosopher in his day, adopts the view of the bellows action, and that the lungs are filled with air, because the chest is dilated, and that without the motion of the thorax they would not be filled. "Indeed," says Boyle, "the diaphragm forms the principal instrument of ordinary and gentle respiration, although to restrain respiration (if I may so call it), the intercostal muscles, and perhaps some others, may concur." *

About this time (1667), Richard Lower† correctly describes the respiratory act, and makes a dog breathe like a broken-winded horse, by dividing the phrenic nerve. These truths were not then relished, so that for nearly 100 years afterwards, a number of unfounded hypothetic and contradictory speculations continued to prevail. A Latin tract ‡ appeared in 1671, and was noticed in the 5th volume of the Transactions of the Royal Society, p. 2141, wherein the author contends that the "lungs do *not* follow the motion of the thorax and diaphragm, nor are moved and plied like bellows, and that the diaphragm *cannot* move up and down;" but the breathing operation is accounted for by curious motions, termed "Extrosum, Introsum, Intumescence, Propulsion," &c.

There appears no proof that Galen believed in the exist-

* Boyle's Works, fol. Lond. 1744, vol. i. p. 64.

† Phil. Trans. Abr. vol. i. p. 179.

‡ Novæ Hyp. de Pulm. Motu et Resp. Lond.

ence of air between the pleuræ, but rather the contrary. Yet, down to the 18th century, this error appears to have prevailed, and is maintained by Hoadly, in his Lectures on Respiration, as read before the Royal College of Physicians in 1737, being the Gulstonian Lectures for that year.

The first great epoch in the history of respiration may safely be dated about the year 1628, at which period Harvey published his first work on the circulation of the blood, though at this time his discovery was not thought an epoch; most persons opposed it, others said it was old, and the epithet "*circulator*," in its Latin invidious signification, was applied to him.

At a very remote period, air was known to possess the quality of weight. Aristotle, and other ancient philosophers, expressly speak of the weight of the air. The process of respiration is attributed by an ancient writer to the pressure of the atmosphere forcing air into the lungs.* Galileo was, therefore, fully aware that the atmosphere possessed this property; yet when his attention was so immediately directed to one of the most striking effects of it, he did not see its connection with respiration. It was reserved for his pupil, Torricelli, to discover (1643) the true law of atmospheric pressure; and, as we can find no true cause assigned prior to this date, why air enters the lungs in inspiration, we may date this as the second true step in knowledge bearing upon our subject. Still it will be found that upwards of twenty years after this, Swammerdam adopted the absurd theory of Descartes, that the air was forced into the lungs by its increased density around the breast, occasioned by the dilatations of the thorax, in consequence of the elevation of the ribs.†

In 1667, Hook kept a dog alive by artificial respiration with bellows.‡

Fabricius, in the beginning of the seventeenth century, explained correctly the action and properties of the diaphragm.||

* Lardner's Cyclop. Nat. Phil.-Hydr. and Pneum. p. 247.

† Thomson's Anim. Chem. 1843, p. 605.

‡ Phil. Trans. Abr. vol. i. p. 194.

|| De Respiratione, ii. c. 8.

Malpighi appears to have been the first who described the structure of the apparatus by which the air is distributed through the lungs, and is enabled to act upon the blood.* In 1672, John Templer considers the "structure of the lungs to be a complication of a multitude of the ramifications of the bronchiæ and sanguineous vessels."†

The function and action of the intercostal muscles has probably excited more disputation than any other subject in physiology, and still appears to require fresh investigation.

Borelli is the earliest physiologist (1679) who established an experimental inquiry into the quantity of air received by a single inspiration.‡ Jurin improves upon Borelli. About this time (1708) Dr. James Keill made some correct cubic measurements of the air breathed out of the lungs.§ Then followed Hales, who threw more light upon the doctrine of the air and force of the heart than all his predecessors, yet he was quite ignorant of the use of respiration, and at this period (1733) little was really known on the subject. In 1757 and following years, Black, Rutherford, Lavoisier, Priestley, and Scheele, threw much light upon the matter, by discovering the composition of the atmosphere and respired air. This may be considered as the second great epoch in the history of respiration. From the time of Black to the present period, we may date all the most valuable information we possess upon the subject.

Respiration may, with propriety, be considered under two grand heads, chemical and mechanical; in such an arrangement, our attention is to be directed to the last division.

3.—*Of the mechanical division of respiration.*—The latitude of movement performed by the walls and floor of the thorax to maintain a constant current of air through the lungs, admits of three common degrees of division :—

* Bostock, Elem. Phys. 1836, p. 311. Malpighi, Epist. de Pulmonibus, i.
† Phil. Trans. Abr. vol. ii. p. 5.
‡ De Motu Anim. p. 2, Prop. 81.
§ Tentam. Med.-Phys. p. 80.

First.—Extreme expansion or enlargement.

Second.—Extreme contraction or diminution. And

Third.—An intermediate condition, an ordinary or quiescent state.

These three divisions necessarily imply a difference in the quantity of air respectively drawn in, and thrown out of, the lungs.

4.—Were these movements but two in number, merely extreme expansion and extreme contraction, the quantity of air moved by such efforts would be easy of calculation and expression, but the intermediate effort, or ordinary breathing movement, being so limited, and so perfectly under the control of the will, mental emotions, and the animal functions, renders the calculation of the quantity of air passing through the lungs a very difficult and complicated question.

5.—The quantity of air in the chest, together with those portions which can be added by the thoracic movements, may be arranged, for perspicuity, under five heads, and denominated—

First.—Residual air.

Second.—Reserve air.

Third.—Breathing air.

Fourth.—Complemental air. And

Fifth.—The vital capacity.

6.—First. *The residual air.*—It is well known that the lungs are not capable of being emptied by the most violent muscular effort; therefore, at all times, as long as the lungs maintain their natural structure, during life or death, a certain quantity of air remains in these organs, which is termed "residual air," and over which we have *no* control.

7.—Second. *The reserve air.*—The gentle respiratory movement, regulating the ordinary breathing, is an intermediate effort between extreme voluntary thoracic contraction and dilatation; and hence it is that a portion of air always remains in the lungs *after* the gentle expiration, which *may* be thrown out if required; to this we have applied the name "reserve air."

8.—Third. *The breathing air.*—That portion required to

perform the ordinary gentle inspiration and expiration, we term "breathing air."

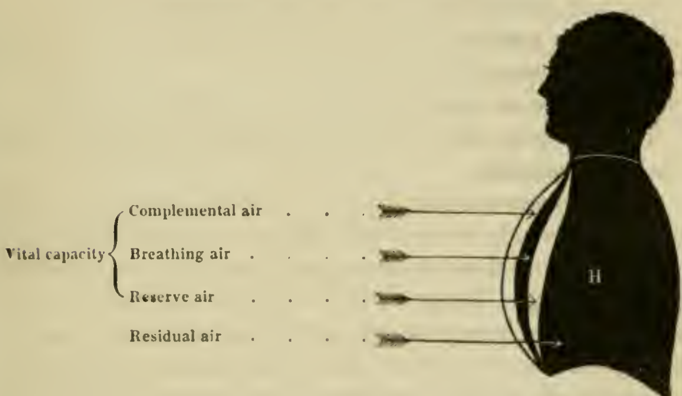
9.—Fourth. *The complemental air* is that portion which *can,* at will, be drawn into the lungs by a violent exertion, (*beyond* the moderate effort of ordinary breathing,) which constitutes the deepest possible inspiration; it is only occasionally added, when required: to this we apply the term "complemental air."

10.—Fifth. *The vital capacity.*—To all these three latter divisions *combined,* being the greatest voluntary expiration, following the deepest inspiration, we apply the term "vital capacity."

This division of the thoracic movements, or portions of air, may be illustrated by the following diagram:—

DIAGRAM 1.

The division of the thoracic movements.



Let that portion marked H represent the "residual air," or air left in the lungs after a complete voluntary expiration; the part next anteriorly marked *white,* the "reserve air," or space for all that air left in the lungs at the termination of an ordinary expiration. The black stripe, the space for the ordinary "breathing air;" the white next anteriorly, the portion for the "complemental air," or extreme deep inspiratory movement; and these three, viz. the complemental, breathing,

and reserve airs, conjointly, we style, for convenience, the "vital capacity," in contradistinction to "absolute capacity," which may be considered as the whole *four* divisions combined. The arrows in Diagram 1 point out these different portions or spaces.

11.—A certain latitude of thoracic movement is required to perform the three divisions under our voluntary control—the reserve, the breathing, and complemental spaces. It is also certain that the quantity of air moved or respired in a healthy person will be strictly governed by the extent of this movement, as the degree of mobility of the sides of the common bellows regulates the cubic quantity of air given out at one blast; and whatever affects this mobility of the boundaries of the chest, must modify the cubic measurement of air taken in, or thrown out of, the lungs, in these divisions, either conjointly or separately considered.

Each of these divisions of air has a peculiar character.

12.—*The residual air* is entirely independent of the will, and always present in the chest.

The reserve air, to use a simile, is a "tenant at will."

The breathing air is constantly passing out and in, many times in a minute.

The complemental air is seldom in the chest, and, when present, it is only so for a brief period. Nevertheless, the air commanded by these movements is constantly interchanging or transfusing. Whatever be the quantity of breathing air required for carrying on the aeration necessary for our well-being, the muscular movement demanded to maintain it, is an intermediate effort, just as the black stripe in the diagram No. 1, just referred to, is intermediate, between the white stripes, so that we may consider, at both ends of the ordinary breathing movement, there exists a spare range of voluntary, muscular mobility. Were there no such reserve muscular mobility of the parietes of the thorax, locomotion or any physical or chemical change in the animal economy would be attended with painful dyspnœa and premature death.

13.—The many varieties of the ordinary breathing movement,

as frequent or infrequent, quick or slow, regular or irregular, great or small, equal or unequal, easy or difficult, complete or incomplete, long or short, abdominal or costal, with those movements attendant on coughing, laughing, crying, sighing, and vociferating, may be considered as so many modifiers of the ordinary and natural breathing, either infringing upon the complemental and reserve air, or, as it will be recollected each of these respiratory divisions admit of two diametrical movements, *inspiring* or *expiring*, the one act must infringe upon the other. The line of demarcation between the breathing air and the complemental and reserve air is more readily imagined than demonstrated, as it is well known that the ordinary quantity of breathing air is immediately increased or diminished upon the attention being directed towards it, which fact accounts for the enormous discrepancy prevailing amongst authors on this subject.

14.—The calculation of this division of respiration (the breathing air) is encompassed with great difficulties, and would require many years to determine it by direct experiment, in a manner to be available to the physician. Considering, too, the time and care it would *always* require to make the calculation, I am inclined to believe that, according to the present mode of examining patients, it will not in our day be used as a means of diagnosis, nor do I think the subject so important as others about to be mentioned.

15.—The subject of this paper resolves itself under the following heads :—

First.—The quantity of air expelled from the lungs, in connection with other physical observations on the human frame.

Second.—The absolute capacity of the thorax, with cubic, superficial and longitudinal measurements.

Third.—The respiratory movements and mobility of the chest.

Fourth.—The inspiratory and expiratory muscular power.

Fifth.—The elasticity of the ribs, and estimate of the voluntary respiratory power.

Sixth.—The effect of decussating, diametrical and oblique power, in reference to the function of the intercostal muscles.

Seventh.—General and practical deductions, to detect disease by the spirometer, with the method of its application.

16.—First. *Of the quantity of air expelled from the lungs, in connection with other physical observations on the human frame.*

Many have attempted experiments upon the cubic measurements of respired air, but the discrepancies are such, that, subject to the terms already appointed (5), a brief account of them may be here introduced.

17.—*Observations hitherto made on the residual air.*—Dr. Hales is indefinite upon this subject, in attempting to measure the superficial extent of the air-cells of the lungs: he adds, "a large allowance must be made for remaining air." *

Allen and Pepys found that the lungs of a stout man (5 feet 10 inches) after death, contained 91·134 cubic inches, and allowing 9 cubic inches for error, and 8 cubic inches for correction of temperature, they estimate this bulk of air at 108 cubic inches.†

Davy estimates it at 41 cubic inches.‡ Goodwyn remarks,§ as the result of three experiments upon culprits, this quantity at 272, 250, and 262 cubic inches, but this he considers is too high, and he determines by four other experiments, the mean of which is 109 cubic inches, as the most legitimate inference.

Kite, who writes expressly upon respiration in connection with submersion, is very obscure on this point; he says, "at the end of a common expiration there are 100 cubic inches of air left in the lungs, which will maintain the lungs in a

* Statistics, vol. i. p. 239.

† Phil. Trans. 1809, vol. xcix. p. 404, 428.

‡ Chem. and Philosoph. Researches, p. 410.

§ Connection of Life with Respiration, p. 24 *et seq.*

middle state of dilatation."* This must either mean the reserve air or residual air, or both combined.

Bostock says, "We shall be in no danger of overrating the quantity if we suppose it to be 120 cubic inches." †

Dunglison ‡ gives the estimate of Menzies at 179 cubic inches; Jurine at 220 cubic inches; Fontana at 40; and Cuvier from 100 to 60; Meckel at 52, and even 40 cubic inches,§ which nearly corresponds with Davy. Dr. Herbert, of Gottingen, after a series of experiments on the capacity of the lungs, concludes, that after a forcible expiration, there is "very little air left in them." ||

18.—*Observations hitherto made on the measurement of the reserve air.*—This has received less attention than any other division. Goodwyn entirely omits it, and this omission was pointed out by a physiologist forty years ago, who, at the time, himself omitted taking any notice of the complemental air. Goodwyn remarks as follows: "If, then, we allow 12 cubic inches for a single inspiration, they will be increased to 14 cubic inches when they get into the lungs; therefore the volume of air (residual air), before in the lungs, receives an addition of 14 cubic inches by an ordinary inspiration. But the volume of air in the lungs before an inspiration was 109 cubic inches; hence it will be increased to 123 cubic inches; therefore the dilatation of the lungs after expiration is to their dilatation after inspiration, as 109 to 123."¶ In other words, he adds the residual and breathing air together, omitting the reserve air between them, which would make a difference of 60 or 70 per cent. in this calculation.

Kite calculates this air at 87 cubic inches.** Davy, by an experiment upon himself, at 77 cubic inches.††

According to Mayo, Dr. Menzies appears indefinite upon

* Essays and Observations, Physiol. and Med. 1795, p. 8.

† Elem. of Physiol. 3rd ed. p. 318.

‡ Human Physiol. 2nd ed. vol. ii. p. 90.

§ Manual of Descrip. and Pathol. Anat. vol. ii. p. 448.

|| Bostock, Op. cit. p. 316; and Archives Gén. de Méd. t. xxi. p. 412 *et seq.*

¶ Op. cit. p. 36, 37. ** Op. cit. p. 47, 48. †† Op. cit. p. 410.

this point, by stating "that many individuals were capable, by a forced expiration, of throwing out an additional 70 cubic inches."*

Bostock, from trials upon himself, fixes this at 160 or 170 cubic inches.† Meckel at 110 cubic inches.‡

19.—*Observations hitherto made on the breathing air.*—This has attracted the most attention; but the discrepancies are nearly commensurate with the number of observations, which vary from 3 to 100 cubic inches, as follows:—

	Cubic inches.		Cubic inches.
Abildgaard, at	3	Fontana, at	35
Abernethy	12	Richerand, Foland, Gordon, and Cavallo, from	30 to 40
Keutsch, from	6 to 12	Hales, Jurin, Sauvages, Haller, Ellis, Sömmering, Thomson, Sprengel, Bostock, Chaptal, Bell, Monro, and Blumenbach, at	40
Goodwyn	3 and 14	Menzies, from	42 to 46
Lavoisier and Seguin	13	Reil, from	42 to 100
Wurzer and Lametherie	8 or 10		
Kite, at	17		
Davy, at	13 and 17		
Allen and Pepys	16·5		
Herbst, from	16 to 25		
Jurin, at	20		
Borelli, from	15 to 40		
Herdolt	25 to 29		
Dalton, at	30		

20.—*Observations hitherto made on the complemental air.*—Davy calculates this air, allowing due correction for temperature, as 119 cubic inches, as determined upon himself.§ Kite says, "at the end of each inspiration, the lungs are capable of containing nearly 200 additional inches." ||

21.—*Observations hitherto made on the "vital capacity."*—Dr. Jurin calculates this at 220 cubic inches, and Hales nearly the same.¶

Davy, experimenting upon himself, and making corrections for temperature, estimates his vital capacity at 213 cubic

* Outlines of Physiol. p. 75 *et seq.*; and Menzies, Op. cit. p. 21.

† Op. cit. p. 316.

‡ Manual of Descrip. Anat. vol. ii. p. 447.

§ Op. cit. p. 410.

|| Op. cit. p. 47.

¶ Hales's Stat. 1732, vol. i. 239.

inches; and he remarks, in a note, "this capacity is probably below the medium—my chest is narrow, measuring in circumference but 29 inches, and my neck rather long and slender." * It is probable the figures 29 are a misprint, instead of 2 feet 9 inches round the chest.

Dr. Thomson examined twelve young men, from 14 to 33 years of age, who varied in their vital capacity from 100 to 250 cubic inches, and the mean of all 186⅓ cubic inches. There is no mention however of the temperature of the respired air. Dr. Thomson himself could expel 193 cubic inches: he remarks, "These experiments were often repeated with the same individual, and the quantity of air which he was able to expel from the lungs was always the same." †

Goodwyn says, "By a full inspiration, after a careful expiration, a man will frequently take into his lungs upwards of 200 cubic inches of air at a single effort." ‡

Kite reckons this "for a moderate sized person as 300 cubic inches." §

Menzies|| states this as often exceeding 200 cubic inches.

Bostock,¶ corroborated by Dunglison,** though *omitting* the complemental air, estimates this at 210 cubic inches.

Lastly. Thackrah†† justly merits much credit amongst observers upon this subject: he gives the mean of 19 experiments upon soldiers, as 217 cubic inches; and he remarks, "A tall young cornet threw out 295 cubic inches;" and this was the greatest quantity he witnessed. He also examined some shoemakers, and found their average as 182 cubic inches.

It may be possible that some of the foregoing details are incorrectly classified; but the subject of respiration is oftentimes so ambiguously treated, that it is very difficult to arrive

* Op. cit. p. 410.

† Thomson's Anim. Chem. 1843, p. 610 *et seq.*

‡ Op. cit. p. 32, note.

§ Op. cit. p. 48.

|| Mayo's Outlines of Physiol. p. 76.

¶ Op. cit. p. 321.

** Op. cit. vol. ii. p. 91.

†† Thackrah, on the Effects of Arts, Trades, &c. on Health, p. 21 *et seq.*

at the true meaning of authors. Nevertheless, according to the most careful consideration, I think it may be reduced to the following:—the

21½.—Residual air ranges from	40	to	260	cubic inches.
Reserve air . . .	77	to	170	do.
Breathing air . . .	3	to	100	do.
Complemental air . .	119	to	200	do.
Vital capacity . .	100	to	300	do.

22.—This forms the basis of our present knowledge, from which I can only gather that observers differ. It is possible that all these experiments may be correct; but allowing this, we cannot thence definitely solve the problem respecting the different quantities of air passing through the lungs.

23.—It appears to me, that two circumstances should be taken into account, before any correct conclusions can be drawn from researches of this nature, or I may add from pathological, physiological, and medical inquiries of almost every kind.

1st. With reference to the number of experiments, and

2nd. With reference to collateral observations on the human frame.

24.—All kinds of research may be considered under two heads,—one where the investigation demands for its solution a multitude of experiments, almost without limitation; and the other where a very limited number at once establishes the point. The chemist quickly determines the presence of carbonic acid gas in the breath, by breathing one deep expiration through lime water, when the insoluble carbonate of lime is immediately precipitated: but the physiologist cannot so speedily determine the *quantity* of air that can be given in such an illustration. One experiment establishes the chemical law, whereas thousands are required to determine the physiological question.

25.—With reference to collateral observations, our comprehension of time, space and weight is relative: no isolated observations in nature can be of much value, particularly those made upon the human frame, if strictly considered

by themselves. The character of man, mental as well as corporeal, so varies, that were we capable of correctly measuring his different qualities, it is most likely no two individuals could be found presenting the same expression of measure. The medical man, when inquiring into the state of his patient, feels the pulse, auscultates the chest, examines the tongue, observes the countenance, desires to know whether the natural secreting organs are acting in excess or in deficiency; and upon combining these data, he grounds his opinion as to the healthiness of the peculiar organs; and for the most part the more extensive his examination, the better is he able to form a correct diagnosis.

26.—The apparent discrepancies of the respiratory powers, determined by the authors already quoted, are entirely due to the following neglect, viz., that there are no collateral accounts, whether they examined males, females, adults, or children. There are no corrections for temperature, nor for the height, weight, or age of the individuals examined. Omitting these points, the bare facts appear thus discordant. I have examined one man who breathed out of his lungs 80 cubic inches, another 464 cubic inches; therefore, with the same propriety, I might say the vital capacity of man ranges from 80 to 464 cubic inches; but the matter appears more comprehensible when I add that the height of the former was only 3 feet 9 inches, and his weight, 4 st. 9 lbs., while the latter measured 7 feet, and weighed 22 stone; but, what is more remarkable, the discrepancy is entirely removed when I state, that by arithmetically reducing the giant to that of the dwarf, the vital capacity of the dwarf is within half an inch of what it actually was, viz., 79·56 cubic inches by calculation, and 80 cubic inches by direct experiment.

27.—The physician, the pathologist, and the physiologist, will gain but little by weighing or measuring the different organs never so correctly, if he at the same time omit taking the height and weight of the body. It is not likely that the heart, lungs or liver of the stout man could maintain in the same manner the vital energies of the spare man or

the tall man. One man is 5 stone, another 25 stone; one 3 feet, another 7 feet. This state of things surely must have a connection with the whole secreting and excreting system. Our structure is like a complicated machine, each portion bearing a certain relation to another, just as the wheels of a clock do to the length of the pendulum; for every length of pendulum demands its own peculiar train of wheels so calculated as to number its oscillation; this oscillation regulates the whole machine. In like manner, the respective development of every man is regulated by some certain and constant capacity or measure of his digestive system as absolutely essential to his respective development, or, we may say, which *regulate* his development. One of the fundamental rules in architecture is "*proportion*," the relation that the whole fabric has to its constituent parts, and which each part has to the complete idea of the whole; for in buildings that are perfect in their kind, from any particular part an architect may form a tolerable judgment of the whole: just in like manner the physiologist, from a portion of the viscera, say an organ, should be able to form a tolerable judgment of the whole man from whom it was taken. From the mere isolated and apparently confused account of the different portions of respired air already mentioned, I am enabled to form some idea of the men examined, though no such account is appended to their experiments. Thus I am entitled to believe that Dr. Jurin and Dr. Hales measured about 5 ft. 8 in., and were between 10 and 11 stone in weight; Davy about 5 ft. 7 in.; Goodwyn under 5 ft. 7 in.; Kite upwards of 6 ft.; Menzies about 5 ft. 5 in.; and Thomson near 5 ft. 7 in.; provided the individuals were in health when the experiments were made.

28.—The individuals I have examined upon the subject of respiration were submitted to the following collateral observations:—

The number of cubic inches given by a full expiration following the deepest inspiration, denominated vital capacity.

The power of the inspiratory muscles.
The power of the expiratory muscles.
The circumference of the chest over the nipples.
The height of the individual.
The weight ditto ditto.
The pulse (sitting).
The number of respirations per minute (sitting).
The age.
The temperature of the breath expired into the Spirometer.
And remarks upon the occupation and general appearance.

29.—*To determine these points,* instruments have been constructed; one for measuring, in cubic inches, the breathed air, which is termed "Spirometer" (208); another for measuring the power of the respiratory muscles; and, lastly, a convenient form of scale and standard for taking the height and weight.

30.—The persons I have examined may be arranged as follows:—

Sailors (merchant service)			121
Fire Brigade of London			82
Metropolitan police			144
Thames ditto			76
Paupers			129
Mixed class (artisans)			370
First Battalion Grenadier Guards			87
Royal Horse Guards (Blue)			59
Chatham recruits			185
Woolwich Marines			573
Pugilists and wrestlers			24
Giants and dwarfs			4
Pressmen	30	Printers	73
Compositors	43		
Draymen			20
Girls			26
Gentlemen			97
Diseased cases			60
		Total number	2130

31.—Each of these individuals breathed three consecutive

times into the Spirometer, because, either from timidity or inexperience, the first observation is frequently not a correct experiment, but by three observations the point sought for is accurately determined. If more than three observations are consecutively made at one time, the number of cubic inches of air will, from fatigue, generally be found to decrease.

32.—So constant is this deep expiratory power, or quantity of air expired, that I have frequently found adults eighteen months or two years afterwards breathe within two or three cubic inches of the original quantity. I have blown into this instrument hundreds of times, and yet I cannot exceed the original quantity determined five years ago.

33.—This is one of the most simple experiments upon respiration, yet to perform it requires some care and attention; persons will sometimes inspire instead of expire, or partially fill the lungs, or partially empty them: or a nervous person may make a curious compound of the whole; but the operator in a very little time, before twenty cases have passed under his observation, will have become so well acquainted with the method of examining, that he can readily tell when the individual has done his utmost, and so determine the correctness of the experiment. (For the application of the Spirometer, see 208.)

34.—The present object being to determine the vital capacity, we shall inquire what are the relations between this and the collateral observations.

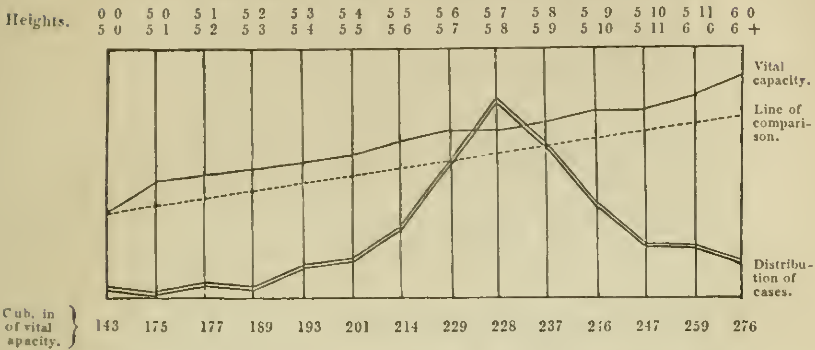
35.—The Vital Capacity of man may be considered as a constant quantity, but this quantity is disturbed directly, or modified by four circumstances:

1st. By Height.	3rdly. By Age.
2ndly. By Weight.	And, 4thly, By Disease.

36.—First. *Of the effect of height.*—The effect of mere height or length of body bears the most marked relation of all these modifiers to the vital capacity, so that I find, if I be allowed to take a man's *height*, I can tell what *quantity* of air he should breathe to constitute him an healthy individual.

DIAGRAM 2.

The vital capacity, in relation to height, on 1923 healthy cases.



To demonstrate this more clearly, let me direct the attention to Diagram No. 2, where a series of perpendicular lines are drawn, which are to indicate different heights: the first line on the left hand is to represent all heights up to, and including, 5 ft.; the second line includes all *from* 5 ft. to, and including, 5 ft. 1 in.; the next *from* 5 ft. 1 in. to, and including, 5 ft. 2 in.; and so on, increasing inch by inch, up to 6 ft.; all above 6 ft. come under the expression of 6 ft. plus.

The continuous horizontal line or curve indicates the relative vital capacity, increasing if it ascends, and decreasing if it descends, as it cuts the perpendicular lines of the different heights. It will be clearly seen that this line ascends nearly in a regular progression as the stature increases from 5 ft. to 6 ft. Therefore the vital capacity in man increases in the same relation. This Diagram is the result of observations upon 1923 cases.

The broken line on Diagram 2 is the line of the arithmetical series, which will be observed to run nearly parallel with the line derived from observation. The figures at the bottom express the mean vital capacity in cubic inches obtained under each of their heights. The double curve, by its ascent and descent, indicates the distribution of the cases, where it will be observed that the greatest number prevailed under 5 ft. 8 in.

37.—The following Table gives a more minute account of the result of this calculation:—

A.—Table of the Mean Vital Capacity of 15 different Classes, or 1923 Cases considered as healthy.

	0 to 5 ft.		5 ft. to 5 ft. 1 in.		5 ft. 1 in. to 5 ft. 2 in.		5 ft. 2 in. to 5 ft. 3 in.		5 ft. 3 in. to 5 ft. 4 in.		5 ft. 4 in. to 5 ft. 5 in.		5 ft. 5 in. to 5 ft. 6 in.	
	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.
Seamen	151	5	206	1	192	7	219	1	218	10	213	9	217	15
Fire-brigade	..	..	..	..	..	..	..	..	210	1	208	2	218	20
Police, Metrop. ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Ditto, Thames ..	158	1	..	..	..	..	..	..	187	6	206	9	228	9
Paupers	151	7	166	3	162	10	180	10	174	21	191	20	189	19
Mixed class	80	1	185	1	162	5	181	5	185	17	191	16	192	20
Grenadier Guards	..	..	..	..	..	..	168	1	..	..	218	1	199	2
Compositors	..	..	..	..	176	3	165	2	196	5	188	6	208	7
Pressmen	..	..	152	1	..	..	..	..	..	..	213	2	203	8
Draymen	..	..	..	..	..	..	..	..	..	..	..	..	192	1
Gentlemen......	..	..	..	..	145	1	161	1	156	7	177	9	189	14
Pugilists, &c.	..	..	..	..	202	1	218	2	218	1	211	4	217	3
Horse Guards ..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Mean of first series	135	14	177	6	173	27	184	22	193	68	208	78	204	118
Chatham recruits	..	..	167	1	181	1	..	..	189	1	..	..	233	19
Woolwich marines	..	..	..	..	..	..	..	..	..	..	216	3	223	7
Miscellaneous ..	..	..	180	1	..	..	194	4	198	4	180	4	196	10
Total mean under each height ..	135	14	175	8	177	28	189	26	193	73	201	85	214	154

	5 ft. 6 in. to 5 ft. 7 in.		5 ft. 7 in. to 5 ft. 8 in.		5 ft. 8 in. to 5 ft. 9 in.		5 ft. 9 in. to 5 ft. 10 in.		5 ft. 10 in. to 5 ft. 11 in.		5 ft. 11 in. to 6 ft.		6 ft. to 6 ft. +	
	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.	Cubic inch.	Cases.
Seamen	226	14	229	15	239	11	258	18	273	12	270	6	246	2
Fire-brigade	215	17	231	26	231	20	237	3	260	1	249	2	..	..
Police, Metrop. ..	234	4	228	33	226	46	248	22	234	13	262	12	281	11
Ditto, Thames ..	222	15	246	17	250	10	240	5	257	3	..	..	..	..
Paupers	210	10	187	9	199	10	262	1	240	3	..	..	..	..
Mixed class	210	20	222	28	238	16	246	14	238	7	269	9	..	..
Grenadier Guards	..	..	228	7	233	22	240	16	232	11	253	9	258	14
Compositors	227	5	215	8	214	6	231	3	..	..	253	1	..	..
Pressmen	204	3	223	7	245	1	239	4	247	2	..	..	..	..
Draymen	241	1	218	3	223	4	245	1	261	6	248	4	..	..
Gentlemen......	208	10	208	18	208	16	236	8	254	12	250	5	262	5
Pugilists, &c.	267	3	206	1	243	2	273	3	272	5	248	2	..	..
Horse Guards ..	..	..	..	..	..	..	..	..	..	..	255	30	275	26
Mean of first series	224	102	220	172	229	164	246	98	254	75	255	82	260	62
Chatham recruits	238	67	247	38	251	22	266	16	236	2	261	5	284	3
Woolwich marines	233	99	235	192	240	130	246	75	250	39	263	18	276	9
Miscellaneous ..	222	18	213	9	230	13	226	12	..	..	259	7	286	6
Total mean under each height ..	229	286	228	411	237	329	246	201	247	116	259	112	276	80

38.—For convenience, the last Table is arranged as follows, in a form for reference when the Spirometer is used.

B.—Table, Height and Vital Capacity in Arithmetical progression.

Height.	Series from Observations on 1012 cases.	Series from Observations on 1923 cases.	Series in Arithmetical Progression.
	First result.	Second Result.	
5 0 / 5 2 } 5 1	175·0	176·0	174·0
5 2 / 5 4 } 5 3	188·5	191·0	190·0
5 4 / 5 6 } 5 5	206·0	207·0	206·0
5 6 / 5 8 } 5 7	222·0	228·0	222·0
5 8 / 5 10 } 5 9	237·5	241·0	238·0
5 10 / 6 0 } 5 11	254·5	258·0	254·0
Mean of all heights	214·0	217·0	214·0

39.—This relation between the height and the vital capacity is more conspicuously demonstrated on Table B. The first column contains the various heights between 5 ft. and 6 ft., increasing arithmetically two inches at a time, as 1, 3, 5, &c. The two next columns are the result of experiments; the first, at an earlier period of this investigation, upon 1012 persons, the next, at a later period, upon 1923 persons.

40.—The mean of all the men from 5 ft. to 5 ft. 1 in. measured their vital capacity at 175 cubic inches in the first result, and 176 cubic inches on a more extended number in the last result; and the men two inches taller (5 ft. 3 in.) at 188·5 and 191 cubic inches.

41.—It will be observed the vital capacity increases with

the height as the eye descends in these columns. The fourth column contains a series of numbers in perfect arithmetical progression, commencing with 174, and increasing 16 every subsequent step. Upon comparing this arithmetical column with those derived from observation, a singularly close resemblance will be observed, particularly if we except the unit figures in each. Therefore it may be said, as these series increase nearly regularly 16 for every two inches of stature upon nearly 2000 cases, the following rule may be deduced:—

42.—"*For every inch of height (from* 5 *ft. to* 6 *ft.) eight additional cubic inches of air, at* 60°, *are given out by a forced expiration.*"

Here is a guide for the operator, and a rule given that will enable us to compare men of different stature and conditions of health one with another.

43.—It will be recollected this difference of the breathing power is solely produced by the effect of stature, every other consideration being sunk in the calculation: this causes the increasing difference between the two series of observations. In the first result, the depressing effect of age lowers the standard of vital capacity, compared with the mean of a different character in the second series, as the Chatham recruits, a *remarkably fine* body of young men, all of whom were correctly examined by Dr. A. Smith, under his personal care and inspection. The Woolwich Marines, are also here included.*

* I would not wish to vouch for the correctness of the observations made upon the *Woolwich Marines*, which were determined by another party, and for two reasons:—First, Because out of 572 men examined, at *all* temperatures, between 62° and 74°, there are—

460 whose capacities terminate with the figure 0.

49 ——————————————————— 5, which figure is not mentioned on the scale.

Moreover the *corrections* for temperature are also omitted; thus the vital capacity of men taken at the temperature of 62° is *compared* with the vital capacity of other men taken at 74°.

And, Secondly,—The weights and physical character of the men are not

44.—*Of the influence of weight on the vital capacity.*—The effect of weight upon the respiratory system, as here investigated, is neither so intimate nor regular as that of height, yet it must be taken into account. I very soon determined that the weight did affect the vital capacity, when it became remarkable or in excess.

45.—So scanty is our knowledge upon human statistics, that it is very difficult to say what is a man's proper weight, and, therefore, as difficult to detect when his weight, by excess, commences to interfere with the respiratory function.

46.—For the most part it will be found that the weight increases with the height, which I have shown remarkably affects the vital capacity, so that to separate the one effect from the other becomes somewhat difficult.

47.—Suppose we take two men of the same common stature, say 5 feet 8 inches: let the one be 10 stone, and the other 14 stone. It will be evident that one is corpulent or stout, possessing weight in excess, but is the other below par or at par? If 10 stone be considered as par, then every ounce above this is *excess weight,* therefore the 14 stone man is *absolutely* 10 stone, and 4 stone in excess. According to this, every ounce of weight increasing upon 10 stone tends towards corpulency or weight in excess, which must, no doubt, interfere with the respiratory system in a certain fixed relation.

48.—As there does not appear to be any account of what the absolute weight of man should be in relation to stature, it is impossible to say where the weight by excess commences: it is, therefore, only in the extremes of weight that

expressed in figures, but in words, as thus,—52 men are described as "spare," 13 "very spare," 65 "muscular," 132 "stout," 19 "stoutish," 112 "middling," with numerous shades between; nevertheless, the reporter speaks favourably of the Spirometer, "as a means of testing the state of the lungs:" he adds, "that those below 200 were deemed unhealthy:" yet it is not unworthy of remark, that when I make correction for the temperature, the increasing progression between the vital capacity and the height is very regular. —See Table (A.) Woolwich Marines.

we can positively state that there exists an excess or deficiency.

49.—The solution of this apparently simple problem of *what is the weight of a healthy man?* would be a valuable boon to society. The promoters of public health would then have more light thrown upon their researches into the effects of trade and locality on life, than by any other investigation. The medical profession, moreover, would possess a rule to guide them in detecting the inroads of disease.

An investigation so simple, and so valuable, should not be omitted. In making statistical inquiries, the government would do well to consider this, and combine the height and weight with the other questions, when taking the census of the country. We should then see more clearly than we do at present, what trade, occupation, or locality, was most conducive or deleterious to life and health. These points, in all their gradations and ramifications, would afford most useful information on matters connected with the social and commercial welfare of the country.

50.—But to turn from this apparent digression to our immediate inquiry into the effect of weight upon the vital capacity. I find, when I sink the height in a calculation of this kind, that little useful matter is obtained, the effect of height being so predominant that it overwhelms the disturbance produced by weight, as will be seen in the following Table:—

Table of the effect of Weight on the Vital Capacity, the Height being sunk.

Weight.	Vital capacity.		Difference.
7 st. to 8 st.	166	+	21 cub. in.
8 ,, 9	187	+	12 ,,
9 ,, 10	199	+	23 ,,
10 ,, 11	222	+	11 ,,
11 ,, 12	233	+	5 ,,
12 ,, 13	238	−	1 ,,
13 ,, 14	237	+	41 ,,
14 ,, 15	278		

I also find the mean vital capacity of 147 men of 11 stone is 225 cubic inches, and that of 32 men of 14 stone only 233 cubic inches, an increase of 8 cubic inches. It also appears that the vital capacity increases from the 7 stone men to the 12 stone men, and then becomes more irregular.

51.—I have made another calculation, keeping the height in view, in the arithmetical increase of inch by inch, and for every 10 lbs. increase by weight. The height extends from 5 ft. to 6 ft. +, and the weight from 100 lbs. to 200 lbs. The observation is made upon 1276 men; the age is here omitted, because, where the numbers are few, certain circumstances the least disturbing must be sunk in the calculation.

D.—Table of the effect of Weight on the Vital Capacity. The Age sunk.

Heights.	lbs. 100 110	Chests.	Cases.	lbs. 110 120	Chests.	Cases.	lbs. 120 130	Chests.	Cases.	lbs. 130 140	Chests.	Cases.	lbs. 140 150	Chests.	Cases.	lbs. 150 160	Chests.	Cases.	lbs. 160 170	Chests.	Cases.	lbs. 170 180	Chests.	Cases.	lbs. 180 190	Chests.	Cases.	lbs. 190 200	Chests.	Cases.
ft. in. ft. in.	c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.		
5 0 to 5 1	177	30	3	187	31	3	141	34	2	140	33	2	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
5 1 to 5 2	178	31	8	156	32	6	180	32	2	174	33	4	196	34	1	..	..	..	..	..	..	150	37	1	..	..	..	..	..	..
5 2 to 5 3	173	30	1	169	31	4	190	32	6	192	34	6	172	33	2	234	37	2	174	37	1	..	..	..	186	40	1	..	..	..
5 3 to 5 4	188	30	3	181	32	6	175	32	17	184	34	20	201	34	13	227	37	2	145	37	1	182	38	7	119	38	2	..	..	..
5 4 to 5 5	168	29	2	168	31	12	182	32	17	190	33	19	206	34	20	207	34	10	181	38	6	..	..	..	..	..	..	..	..	..
5 5 to 5 6	..	..	..	170	33	4	196	33	16	188	33	39	208	34	37	208	35	20	202	36	10	176	38	3	218	38	2	..	..	..
5 6 to 5 7	..	..	..	198	33	3	219	32	31	216	33	40	223	34	60	224	34	25	223	36	13	191	38	5	229	41	2	184	39	3
5 7 to 5 8	..	..	..	228	31	5	215	32	12	197	34	32	221	34	74	209	35	41	227	36	32	214	38	9	224	38	5	182	39	2
5 8 to 5 9	..	..	..	196	33	1	200	31	9	213	33	23	220	35	50	211	35	40	242	36	45	228	37	18	231	38	9	220	39	4
5 9 to 5 10	..	..	..	200	31	1	241	32	3	235	33	10	241	34	22	239	36	30	244	36	32	274	38	15	246	38	7	214	39	5
5 10 to 5 11	..	..	..	195	30	1	185	31	2	208	33	2	254	34	8	238	36	20	217	35	18	248	38	13	278	38	8	237	38	5
5 11 to 6 0	..	..	..	..	..	..	..	..	..	243	33	2	244	35	5	264	36	16	259	36	13	251	37	34	261	38	10	263	41	5
6 0 to 6 +	..	..	..	..	..	..	..	..	..	260	33	2	243	36	2	253	35	4	279	39	11	281	37	17	274	38	16	275	39	10
Total mean..	176	30	17	186	31	46	196	32	117	203	33	201	219	34	294	228	35	210	217	36	182	219	37	112	226	38	62	221	39	35

52.—From this Table it appears the effect of weight on the vital capacity is irregular.

To make the influence as clear as possible, I condense the total mean, as follows, from Table D.

E.—Table reduced from the last, of the effect of Weight on the Vital Capacity.

Weight in lbs.	Cubic inches for every 10 lbs.	Cubic inches for every 20 lbs.	Difference.
100–110	176	181	+ 18
110–120	186		
120–130	196	199	+ 24
130–140	203		
140–150	219	223	– 5
150–160	228		
160–170	217	218	+ 5
170–180	219		
180–190	226	223	
190–200	221		

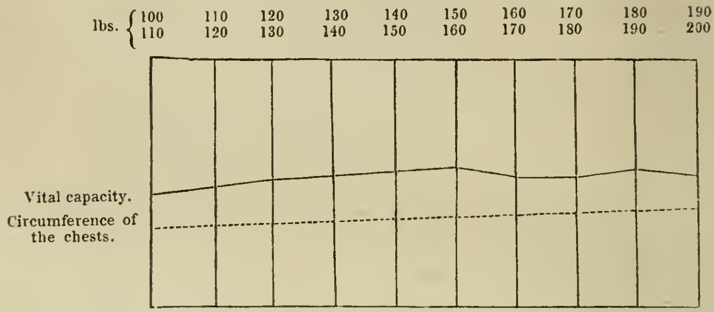
53.—It seems the vital capacity increases 42 cubic inches with the weight from 100 lbs. to 155 lbs., and from 155 lbs. to 200 lbs. the effect is balanced by minus 5 and plus 5 cubic inches. In the first division (Table E.) there is an increase of 42 cubic inches; in the second division there is a decrease of 42 cubic inches in the vital capacity.

54.—I have delineated this by curves upon Diagram 3 (next page). The continuous line will be seen at first to ascend as it passes over the perpendicular lines, which lines represent the respective cases increasing in weight in decimal portions of 10 lbs. at a time, from 100 to 200 lbs. This curve will be seen as

highest at 160 lbs., and from thence it continues nearly horizontal as it passes the remaining heights up to 200 lbs.

DIAGRAM 3.

The effect of weight on the vital capacity.



55.—According to this, it may be said that the vital capacity increases nearly in the ratio of 1 cubic inch per lb., from 105 to 155 lbs., and that, from 155 to 200 lbs., this increase is overpowered, and there is a loss of 39·5 cubic inches as the effect of weight.* Therefore, all weight under 11½ stone does not interfere with the vital capacity, but, on the contrary, it increases with the weight up to this point, but above this weight, as far as our Table goes (viz. to 14 stone), the weight interferes with the vital capacity, preventing this increasing progression in the relation of rather more than 1 cubic inch to the lb.

56.—The influence of weight, as shown by these Tables, is calculated for the height of 5 feet 6 inches, being the mean of all heights between 5 feet and 6 feet; therefore to this height *only* these points of weight (from 11½ stone to 14 stone) refer.

The weight of man naturally increases with his stature,

* This loss of 39·5 cubic inches must be added to 2·5 cubic inches, the mean of the 5 minus and 5 plus cubic inches, in the 2nd division, Table E., making a total loss of 42 cubic inches.

therefore the relation between the weight and the vital capacity must also vary at different heights.

57.—If it be granted that, at the height of 5 feet 6 inches, the vital capacity commences to be affected, when the weight exceeds 11½ stone, it cannot be expected, when a man is 6 inches taller, (whose natural weight considerably exceeds 11½ stone,) that from this *same* point his vital capacity is affected in the relation of 1 cubic inch per lb. Accordingly, I have calculated the weights, in relation to all heights, from the cases I examined, together with 1554 cases of men in the prime of life, obligingly furnished me by Mr. Brent, whose weights I believe to be correct, and the following is the result:—

58.—F.—Table of the Mean Weight in relation to Height on 3000 Males,* at the middle period of life (from 15 to 40), including the Weight of their Clothes.†

Heights.	No. of Cases.	Gross weight in lbs.	Mean weight in lbs.
ft. in. ft. in.			
4 6 to 5 0	26	2399	92·26
5 0 to 5 1	17	1964	115·52
5 1 to 5 2	36	4476	124·33
5 2 to 5 3	43	5497	127·86
5 3 to 5 4	88	12145	138·01
5 4 to 5 5	126	17537	139·17
5 5 to 5 6	214	31016	144·93
5 6 to 5 7	316	45598	144·29
5 7 to 5 8	379	57822	152·59
5 8 to 5 9	468	73835	157·76
5 9 to 5 10	368	61238	166·40
5 10 to 5 11	348	59460	170·86
5 11 to 6 0	245	43475	177·45
6 0 to 6 +	326	71283	218·66
Total . . .	3000	487745	147·86

* The classes whence these cases are taken are as follows:—Sailors, firemen, metropolitan police, Thames police, paupers, artizans, labourers, Grenadier Guards, Horse Guards, printers, draymen, wrestlers, pugilists, Oxford and Cambridge rowers, London watermen, cricketers, pedestrians, and gentlemen.

† M. Quetelet says, the average weight of the clothes at different ages is one-eighteenth of the total weight of the male body, and one-twenty-fourth part of the total weight of the female.—Quetelet sur l'Homme, &c.

From this Table it will be seen that the weight increases with the height, as from 92 lbs. to 218 lbs. To make the progression more apparent, I arrange the above in another order.

G.—Table of the difference of Weight, in relation to Stature, on 2648 Males, taken from the last Table.

Exact stature.		Weight in lbs.	Weight in lbs. more exactly.	Difference of weight in lbs.
ft. in.	In inches.			
5 1	61	120	119·9	+ 6·2
5 2	62	126	126·1	+ 6·8
5 3	63	133	132·9	+ 5·7
5 4	64	139	138·6	+ 3·5
5 5	65	142	142·1	+ 2·5
5 6	66	145	144·6	+ 3·8
5 7	67	148	148·4	+ 6·8
5 8	68	155	155·2	+ 6·9
5 9	69	162	162·1	+ 6·5
5 10	70	169	168·6	+ 5·6
5 11	71	174	174·2	

This is determined by adding the mean weight from Table F., of the men from 5 feet to 5 feet 2 inches (the mean of which height is exactly 5 feet 1 inch), together, and taking the mean of that, which will be found 119·9 lbs.; and the next from 5 feet 1 inch to 5 feet 3 inches, taking their mean as 126·1 lbs. and so on.

59.—The range of stature from 5 feet 1 inch, to 5 feet 11 inches, is 10 inches: and the weight rises from 119·9 lbs. to 174·2 lbs., or 54·3 lbs., or 5·43 lbs. to every inch of stature.

To subdivide this range of height it may be said—

	lbs.		ft. in.		ft. in.
Their rise is	6·2	from	5 1	to	5 4
————	3·3	—	5 4	—	5 7
————	6·5	—	5 7	—	5 11

The inequality from 5 feet 4 inches to 5 feet 7 inches may disappear when the observations are extended: at present it may be stated generally that the weight increases 6·5 lbs. (or $6\frac{1}{2}$ lbs.) for every inch of stature from 5 feet

7 inches to 6 feet, and 6·2 lbs. for every inch of stature from 5 feet 1 inch to 5 feet 4 inches: from 5 feet 4 inches to 5 feet 7 inches the increase is nearly half of 6·5, or 3·3 lbs. for every inch.

At 5 feet 8 inches, or 68 inches, of stature, the weight is 155·2 lbs., or nearly 11 stone; from this, as a starting point, the weight at any other height may (so far as our limited observations warrant) be readily calculated. For instance:—

The weight is, at the height of 5 feet 8 inches, $\frac{155 \cdot 2}{68}$ = 2·282 lbs. for every inch of stature, or 27·38 lbs. for every foot. As a pound of water = 27·727 cubic inches, the bulk of the human body may be represented by a cylinder of water of 68 inches high, and nearly 9 inches (8·9761) in diameter.

From geometry it is shown that the bulk or weight of symmetrical bodies is as the 3rd power (cubes) of any of the diameters: thus, if a person 67 inches high weigh 148·44 lbs., a person 69 inches high should weigh,

$$\left(\frac{69}{67}\right)^3 \times 148 \cdot 44 = \frac{69 \times 69 \times 69}{67 \times 67 \times 67} \times 148 \cdot 44 = \frac{328509}{300763} \times 148 \cdot 44 = 162 \cdot 14 \text{ lbs.}$$

The weight at that height from *observation* was 162·08 lbs., and from *calculation* 162·14 lbs.

Taking the height from 67 to 71 inches, we have as follows:—

II.—Table of the Calculated Weight, compared with the Observed Weight.

Height in inches.	Weight determined by calculation.	Weight determined by direct observation.
	lbs.	lbs.
67	148·8	148·4
68	155·2	155·2
69	162·1	162·1
70	169·3	168·6
71	176·6	171·2

The lower heights are heavier than they should be, the higher, lighter than they should be, symmetrically. The weights indeed vary as the 2·75th power of the height, and not as the 3rd power.

60.—To bring these two last Tables E. and G. upon weight, to bear upon the statement (55) of the effect of weight on the respiratory function, I may venture to infer that as the calculation of the effect of weight is made at the fixed height of 5 feet 6 inches, and that, at this height, a man must attain the weight of 155 lbs. before his vital capacity is diminished, and that the average weight of this height is 145 lbs., therefore he may exceed his average weight by 10 lbs., or 7 per cent. before his vital capacity is effected by weight. Presuming this last opinion, we may probably be allowed to consider that the starting point from whence we may commence to count *excess* weight as interfering with the vital capacity as 7 per cent. upon the mean weights given in Table G. For example:—The weight of the men of 5 feet 1 inch is 119·9 lbs., add to this 7 per cent. (8·395 lbs.) weight, making 128·2 lbs.; again, the tallest men, 5 feet 11 inches, weigh 174·2 lbs., to this add 7 per cent. (12·2 lbs.), making 186·4 lbs.: therefore, at the height of 5 feet 1 inch, a man must exceed 128 lbs., or 9 stone 2 lbs., and the 5 feet 11 inch man 186 lbs. or 13 stone 4 lbs., before weight may be expected to diminish the vital capacity, in the relation of 1 cubic inch per pound for the next 35 lbs., or 2½ stone, being the limit of the calculation. I believe it will be found, that when the weight exceeds this limit, the vital capacity will considerably decrease, and that probably in a geometrical relation, from the mere circumstance of fat preventing the mobility of the thoracic boundaries.

I have not found the vital capacity altered in healthy men below the mean weight.

From what has been said, the examination of corpulent persons must not be compared with those not corpulent, though in all other respects the same.

This effect of weight in diminishing respiration, need not

in the least confound the observer, when examining a case with reference to phthisis, or any other chest disease; the use of the scales, together with other physical observations, will sufficiently protect him from such an error.

61.—*Of the effect of age upon the vital capacity.*—As might be anticipated, age affects the vital capacity, but not so remarkably as the two preceding causes; the first calculation, however, upon 1088 cases, did not make it apparent. This was in consequence of examining such a mixed multitude at all ages. But, after the examination of the Chatham recruits, I found the effect of age was very marked, causing the difference between the two columns in Table B., page 157, on 1012 and 1923 cases. This is more fully seen in Table A., where the vital capacity of every class is compared. I now subjoin a Table of the effect of age on the vital capacity, the *weight* in this case being sunk.

I.—Table of the effect of Age upon the Vital Capacity, on 1775 Healthy Cases.

Heights.	Age, 15 to 20.	Cases.	Chests.	Age, 20 to 25.	Cases.	Chests.	Age, 25 to 30.	Cases.	Chests.	Age, 30 to 35.	Cases.	Chests.	Age, 35 to 40.	Cases.	Chests.	Age, 40 to 45.	Cases.	Chests.	Age, 45 to 50.	Cases.	Chests.	Age, 50 to 55.	Cases.	Chests.	Age, 55 to 60.	Cases.	Chests.	Age, 60 to 65.	Cases.	Chests.
ft. in. ft. in.	c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.			c. in.		
5 0 to 5 1	231	3	30	182	1	31	219	1	31	..	..	..	152	1	31	150	1	34	..	..	..	..	..	..	130	1	34	141	2	34
5 1 5 2	188	9	32	178	4	32	164	3	33	..	..	..	173	1	33	125	3	34	..	..	..	..	..	..	145	1	35	167	1	33
5 2 5 3	178	5	31	205	5	34	226	1	36	213	4	34	..	..	..	194	1	36	168	3	34	..	..	..	167	2	30	179	2	34
5 3 5 4	198	10	31	191	11	33	199	9	35	206	6	34	192	6	32	179	9	34	185	2	36	198	6	35	156	5	35	146	3	36
5 4 5 5	185	13	31	208	15	33	203	11	33	210	8	34	191	6	35	193	7	35	163	6	33	188	7	35	202	4	33	173	3	31
5 5 5 6	214	17	34	221	38	34	209	16	35	215	15	34	203	19	34	207	7	35	183	8	37	165	8	35	178	3	36	165	4	36
5 6 5 7	243	65	34	230	78	33	235	56	35	232	28	36	206	25	35	216	12	35	216	11	34	155	2	40	197	4	38	198	3	34
5 7 5 8	242	81	34	224	116	34	232	79	35	232	53	35	217	34	34	209	15	36	189	9	36	183	4	36	213	4	38	160	3	35
5 8 5 9	241	38	35	239	107	35	222	64	35	228	57	35	220	27	35	223	16	36	204	8	37	211	6	35	194	1	38	215	3	38
5 9 5 10	252	27	35	247	67	34	249	48	36	254	25	38	275	13	37	225	11	38	203	3	39	210	2	35	203	3	40	..	..	..
5 10 5 11	218	6	33	262	29	36	242	34	35	257	26	36	242	22	37	237	4	37	220	3	35	220	1	38	219	2	35	270	1	41
5 11 6 0	254	9	35	264	20	36	272	25	37	239	20	37	265	17	37	264	7	39	240	2	35	209	1	41	..	..	..	200	1	38
6 0 6 +	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..
Total mean ..	220	283	33	220	491	34	222	347	34	228	242	35	212	171	34	201	93	35	197	55	35	193	37	36	182	30	36	183	26	35

Treating this Table upon the same system as the last, it is here reduced as follows :—

J.—Table arranged from the last Table, reduced to decimal periods of time.

<table>
<tr><th>Age.</th><th>Cubic inches.</th><th>Cases.</th><th>Circumference of chest.</th><th>Vital capacity for every 10 years.</th><th>Difference.</th></tr>
<tr><td>15 to 20</td><td>220</td><td>283</td><td>34</td><td rowspan="2">220</td><td rowspan="2">+ 5</td></tr>
<tr><td>20 to 25</td><td>220</td><td>491</td><td>34</td></tr>
<tr><td>25 to 30</td><td>222</td><td>347</td><td>34</td><td rowspan="2">225</td><td rowspan="2">– 19</td></tr>
<tr><td>30 to 35</td><td>228</td><td>242</td><td>35</td></tr>
<tr><td>35 to 40</td><td>212</td><td>171</td><td>34</td><td rowspan="2">206</td><td rowspan="2">– 11</td></tr>
<tr><td>40 to 45</td><td>201</td><td>93</td><td>35</td></tr>
<tr><td>45 to 50</td><td>197</td><td>55</td><td>35</td><td rowspan="2">195</td><td rowspan="2">– 13</td></tr>
<tr><td>50 to 55</td><td>193</td><td>37</td><td>36</td></tr>
<tr><td>55 to 60</td><td>182</td><td>30</td><td>36</td><td rowspan="2">182</td><td rowspan="2"></td></tr>
<tr><td>60 to 65</td><td>183</td><td>26</td><td>35</td></tr>
<tr><td>Mean of all ages</td><td>205·8</td><td>1775</td><td>35</td><td></td><td></td></tr>
</table>

62.—The column of "difference" points out the effect of age. This agrees with our experience: time as we see affects the animal kingdom in a two-fold manner, first bringing it to perfection, and then deteriorating it.

63.—From 15 to 35 years of age, the vital capacity is increased, and from 35 to 65 years of age, it is decreased in the progression of 19, 11, and 13 cubic inches.

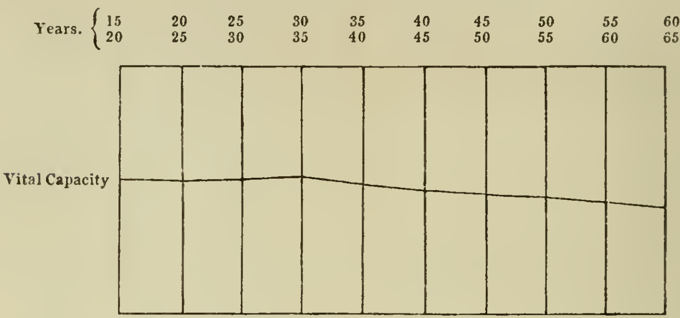
In the same manner as before, I have illustrated this by lines on Diagram 4 (next page), where the curve of the vital capacity will be seen to descend after it passes the perpendicular

line of 35 years of age, and keeps declining as it cuts all the preceding lines of quinquennial periods of age, down to 65.

64.—The vital capacity therefore, from this Table (Table J.), increases with the age up to 30 years, and from 30 to 60 it decreases 43 cubic inches, or 1·43 (nearly $1\frac{1}{2}$ cubic inches) per year, or 7 cubic inches in 5 years, or $14\frac{1}{3}$ cubic inches in 10 years.

Diagram 4.

The effect of age on the vital capacity.



65.—This quantity being small, it will readily be imagined that such an effect upon a small number of men of all ages would escape detection.

66.—It will doubtless have occurred to the minds of some present, Has the size of the chest no relation to the vital capacity? I shall refer to this more particularly under the next head, on the absolute capacity of the thorax; nevertheless, a remark upon the effect of the circumference will not here be out of place.

67.—Contrary to what I ever expected, (and agreeable to the opinion of others,) I do not find there exists any direct relation between the circumference of the chest and the vital capacity.

68.—I have found by one of my Tables upon the circumference of the chest, (not here introduced,) that the mean vital capacity of 11 men of 5 feet 8 inches whose chests measure 35 inches in circumference over the nipples, is 235 cubic inches,

while that of 10 men of the same height, whose chests are 38 inches (3 inches more), is only 226, being 9 cubic inches less.

69.—The following Table is an epitome of this calculation.

K.—Table of Circumference of the Chest, in relation to the Vital Capacity, in 994 cases.

Circumference of chest.	Mean cubic inches.	No. of cases.	Cubic inches difference.
inches.			
30 to 30½	200	14	−13
30½ to 31	187	20	+18
31 to 31½	206	21	−10
31½ to 32	196	35	+ 1
32 to 32½	197	32	− 7
32½ to 33	204	50	− 2
33 to 33½	202	44	0
33½ to 34	202	63	+11
34 to 34½	213	70	+ 4
34½ to 35	217	78	− 2
35 to 35½	215	71	+14
35½ to 36	229	74	−10
36 to 36½	219	59	+ 2
36½ to 37	221	97	+18
37 to 37½	239	59	− 4
37½ to 38	235	57	−13
38 to 38½	222	41	+ 8
38½ to 39	230	40	− 6
39 to 39½	224	18	+ 2
39½ to 40	228	37	−11
40 to 40½	217	14	0

The height is here kept in view, and is calculated at 5 feet 6½ inches. Nothing regular presents itself, probably owing to the weight being sunk, as fat on the chest will both increase its dimensions, and decrease its vital capacity; therefore I find on looking into the calculations, such apparent discrepancies as 15 men of 5 feet 9 inches having a vital capacity of 233 cubic inches; while 11 men of the same height, but whose chests measured 3 inches larger, had only a vital capacity of 232 cubic inches, and the mean of 14 men of 30½ inches circumference 204 cubic inches; while that of 14 men of 40½ inches only 217 cubic inches; and one out of these had a vital capacity of 57 cubic inches below that of the men whose chests were 10 inches less. Hence the *absolute* breadth of the chest is not a direct or ready guid to estimate the vital capacity.

70.—I may here mention, that it was in consequence of so often witnessing tall, thin, and narrow-chested men, breathing so much more air than broad-chested men, that I was first led to consider and combine the height with these observations. I examined nearly 200 men with no satisfactory result, until I introduced the height into the examination, which so completely arranged the whole research in the order I have described.

Nevertheless, under certain circumstances the size of the chest will be found to affect the vital capacity, as when we have a thoracic mobility of 3 inches on a 40-inch chest, we shall find a greater vital capacity than with the same mobility on a smaller chest.

71.—The most remarkable relation of the circumference of the chest is to that of the *Weight*, with which it increases in an *exact* arithmetical progression of 1 inch for every 10 lbs.

It will be seen in Table D., page 162, that the men of 100 and 110 lbs. have chests of 30 inches, and those of the next 10 lbs. increase 1 inch; and so on in perfect progression. I have illustrated this on Diagram 3, page 164, with a dotted line, where the increase will be seen perfectly regular as it passes over the perpendicular lines of increasing weights.

72.—To conclude this portion of the inquiry, it may be added, that the healthy vital capacity is chiefly affected by three circumstances—height, weight, and age.

By height, an increase of 8 cubic inches at 60° for every inch of height (42).

By weight (at the height of 5 feet 6 inches), the vital capacity is not affected under 161 lbs., or 11½ stone; but above this point it diminishes the vital capacity in the relation of 1 cubic inch per lb. up to 196 lbs., or 14 stone. And at other heights, between 5 feet 1 inch and 5 feet 11 inches, ten per cent. may be added to the mean height, (given in Table G., p. 166,) before we allow the weight to affect the vital capacity in the relation of 1 cubic inch per lb.

By age (from 35 to 65), a decrease of rather more than 1 cubic inch per year.

73.—SECONDLY. *Of the absolute capacity of the thorax, with cubic, superficial, and longitudinal measurements.*—Finding that different men breathed such different quantities of air, and that too chiefly in relation to height (which principally depends upon the length of the legs), I was anxious to determine by direct experiment, whether the depth or breadth of the thorax corresponded with the increase of stature. Finding little light thrown on this question in the physiological works I consulted, I had recourse to the following series of experiments to solve the point. For the opportunity of making these, I am indebted to the kindness of my friend, Dr. Boyd, of the Marylebone Infirmary.

74.—I examined 20 bodies; 6 females and 14 males. I made an opening over the sternum into the chest, just large enough to admit my hand; the heart and lungs were removed, the cavity was then perfectly filled with plaster of Paris, the sternum returned into its original position, and kept there until the plaster was hard, then the abdomen was opened, the diaphragm removed, and the cast withdrawn from the cavity of the thorax. (The casts were exhibited before the Society.)

75.—The height and weight of the body were previously taken, also the weight of the heart and lungs together, with the cause of death. These casts I have submitted to numerous measurements, as their length, breadth, depth, superficial and cubic dimensions, the whole of which are, on the next page, arranged in a tabular form. I believe this method will furnish us with correct measurements of the thorax.

76.—There required no precautions as some think for fixing the diaphragm; I believe it did not vary from its natural position, the abdominal viscera keeping it perfectly fixed on one side, which I found was not disturbed by the weight of the plaster: there is *more* danger to be apprehended from the elasticity of the ribs, which becomes very apparent when once we cut through these elastic arches; therefore the opening was kept as small as possible,—a necessary precaution to be observed.

L.—Table of Various Measurements of the Thorax, 14 Males and 6 Females. The Weights and Heights are given without their Dress.

Initials.	Sex.	Age.	Height.		Weight.	Weight of the Heart.	Weight of Right Lung.	Weight of Left Lung.	External Circumference over Nipples.	Internal Circumference, largest part.	Ditto of Right Half of Chest.	Ditto, Left ditto.	Superficial Inches of Internal Walls of the Chest.	Superficial Inches of the Diaphragm.	Superficial Inches of the entire Cavity of Chest.	Cubic Inches of Right Half of Chest.	Cubic Inches of Left ditto.	Ditto of Entire Cavity of Chest.	Depth of Right Lung from Apex to Arch of Diaphragm.	Depth of Left Lung from Apex to Arch of Diaphragm.	Depth from between Apices to Arch of Diaphragm.	Depth from before, backwards, of Right Lung (Maximum).	Depth from before, backwards, of Left Lung (Maximum).	Greatest Depth from before, backwards, of Chest.	Distance between Sternum and bodies of Dorsal Vertebræ.	Projection of Dorsal Vertebræ into Cavity of Thorax.	Greatest Breadth of Cavity of Thorax.	The Highest Apex of Lungs.	Distance between Centre of Apices of Lungs.	Vital Capacity of such Chests.
		yrs.	ft.	in.	lbs.	oz.	oz.	oz.	in.	in.	in.	in.	s. in.	s. in.	s. in.	c. in.	c. in.	c. in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	lung.	in.	c. in.
E.	Fem.	30	4	6	72	9	$16\frac{1}{2}$	21	32	$24\frac{1}{2}$	$14\frac{1}{4}$	$13\frac{3}{4}$	198	39	238	107	128	235	7	$7\frac{6}{8}$	7	6	$6\frac{1}{2}$	$6\frac{6}{8}$	$4\frac{5}{8}$	$2\frac{7}{8}$	$7\frac{5}{8}$	Right	$2\frac{1}{4}$	170
D.	Fem.	55	5	1	50	6	$7\frac{1}{2}$	$9\frac{1}{2}$	$25\frac{1}{2}$	$23\frac{1}{2}$	$13\frac{1}{2}$	$12\frac{1}{3}$	237	30	267	127	140	267	$8\frac{6}{8}$	$9\frac{1}{8}$	$7\frac{7}{8}$	$6\frac{1}{2}$	6	$6\frac{1}{8}$	$4\frac{3}{8}$	$2\frac{1}{2}$	$7\frac{6}{8}$	Right	$1\frac{6}{8}$	174
K.	Fem.	62	5	3	85	$9\frac{3}{4}$	$22\frac{3}{4}$	$13\frac{3}{4}$	$28\frac{1}{4}$	23	$12\frac{1}{4}$	$12\frac{1}{2}$	189	30	219	95	129	224	$6\frac{3}{8}$	$7\frac{5}{8}$	$7\frac{3}{8}$	$5\frac{3}{8}$	$5\frac{1}{4}$	6	$4\frac{1}{4}$	$2\frac{1}{4}$	8	Left	$2\frac{1}{2}$	190
V.	Fem.	23	5	4	109	$9\frac{3}{4}$	$15\frac{3}{4}$	$9\frac{3}{4}$	$29\frac{3}{4}$	24	$13\frac{1}{4}$	13	180	38	218	84	111	195	$6\frac{1}{8}$	$7\frac{6}{8}$	$6\frac{1}{4}$	$5\frac{1}{2}$	$5\frac{3}{8}$	$5\frac{6}{8}$	$3\frac{5}{8}$	$2\frac{1}{4}$	$8\frac{3}{8}$	Right	$2\frac{5}{8}$	197
G.	Fem.	39	5	4	125	$18\frac{3}{4}$	28	18	32	$24\frac{1}{2}$	$14\frac{1}{4}$	14	247	36	283	129	206	335	$7\frac{3}{8}$	8	$6\frac{5}{8}$	$6\frac{3}{8}$	6	$6\frac{3}{4}$	$4\frac{1}{8}$	$2\frac{5}{8}$	$8\frac{1}{4}$	Left	$2\frac{1}{4}$	197
M.	Fem.	35	5	6	125	17	22	33	31	$23\frac{3}{4}$	13	$13\frac{1}{4}$	220	36	257	112	136	248	$7\frac{7}{8}$	$8\frac{5}{8}$	$7\frac{6}{8}$	$4\frac{6}{8}$	$5\frac{3}{8}$	$5\frac{7}{8}$	$3\frac{3}{8}$	$2\frac{1}{2}$	$8\frac{5}{8}$	Right	$2\frac{5}{8}$	194
Z.	Male	74	5	4	74	$8\frac{3}{4}$	30	$18\frac{3}{4}$	$28\frac{3}{4}$	$26\frac{3}{4}$	$14\frac{3}{4}$	$13\frac{7}{8}$	262	41	303	167	168	335	$7\frac{7}{8}$	$10\frac{1}{2}$	$9\frac{5}{8}$	$6\frac{1}{8}$	$6\frac{1}{4}$	$6\frac{3}{8}$	4	$2\frac{1}{4}$	$9\frac{1}{2}$	Left	3	161
F.	Male	43	5	5	77	$9\frac{1}{4}$	36	$31\frac{1}{2}$	$27\frac{1}{2}$	$25\frac{1}{4}$	14	$13\frac{7}{8}$	280	36	316	155	200	355	$8\frac{7}{8}$	$9\frac{1}{2}$	$8\frac{1}{2}$	$6\frac{5}{8}$	$6\frac{3}{8}$	$6\frac{6}{8}$	$4\frac{5}{8}$	$2\frac{3}{8}$	$8\frac{6}{10}$	Left	$2\frac{6}{8}$	188
H.	Male	38	5	5	107	$10\frac{1}{2}$	$22\frac{1}{2}$	$20\frac{1}{2}$	32	29	$16\frac{1}{2}$	$15\frac{1}{4}$	258	53	311	170	186	356	$7\frac{3}{4}$	$8\frac{1}{2}$	$7\frac{1}{4}$	7	$6\frac{3}{8}$	$7\frac{1}{2}$	$4\frac{3}{4}$	3	$9\frac{5}{8}$	Right	$2\frac{1}{2}$	189
T.	Male	80	5	6	82	$11\frac{1}{2}$	$18\frac{1}{2}$	$17\frac{1}{2}$	30	$26\frac{3}{4}$	15	$14\frac{1}{2}$	234	47	281	143	157	300	$6\frac{7}{8}$	$8\frac{1}{8}$	6	$7\frac{1}{8}$	$7\frac{1}{10}$	$7\frac{1}{8}$	5	$2\frac{1}{4}$	$8\frac{3}{10}$	Left	$3\frac{3}{4}$	188
L.	Male	40	5	6	92	$8\frac{1}{4}$	27	$33\frac{1}{4}$	29	25	$14\frac{1}{4}$	13	234	41	275	138	148	286	8	$8\frac{1}{2}$	$8\frac{5}{8}$	$5\frac{7}{8}$	$5\frac{1}{8}$	$7\frac{5}{8}$	$4\frac{1}{8}$	$1\frac{7}{8}$	9	Right	$2\frac{1}{2}$	188
B.	Male	78	5	$6\frac{1}{4}$	145	24	21	17	35	$30\frac{1}{2}$	$16\frac{1}{4}$	17	283	56	339	157	222	379	$7\frac{1}{2}$	8	$8\frac{6}{8}$	$7\frac{6}{8}$	$7\frac{6}{8}$	$8\frac{1}{4}$	$5\frac{1}{8}$	$2\frac{6}{8}$	$9\frac{7}{8}$	Right	$3\frac{3}{8}$	213
C.	Male	39	5	7	94	$10\frac{1}{2}$	$49\frac{1}{2}$	37	$31\frac{1}{2}$	$27\frac{1}{4}$	15	14	277	44	321	165	183	348	$8\frac{6}{8}$	$8\frac{5}{8}$	$8\frac{3}{8}$	$5\frac{3}{4}$	$6\frac{1}{4}$	$6\frac{7}{8}$	$4\frac{1}{4}$	$2\frac{3}{4}$	$9\frac{5}{8}$	Right	$2\frac{7}{8}$	210
S.	Male	77	5	7	157	21	24	24	39	31	$16\frac{1}{2}$	$16\frac{1}{4}$	318	57	375	215	242	457	$7\frac{6}{8}$	$8\frac{6}{8}$	8	$7\frac{1}{2}$	$7\frac{7}{8}$	$7\frac{1}{2}$	5	$2\frac{1}{4}$	$11\frac{1}{4}$	Same	$3\frac{1}{4}$	202
O.	Male	48	5	8	92	$15\frac{1}{2}$	43	$29\frac{1}{2}$	$30\frac{1}{2}$	28	$15\frac{1}{8}$	$17\frac{7}{8}$	276	43	319	157	217	374	$8\frac{3}{8}$	$10\frac{3}{8}$	8	6	$5\frac{7}{8}$	$6\frac{1}{4}$	$3\frac{7}{8}$	$2\frac{3}{10}$	$10\frac{3}{8}$	Right	$2\frac{3}{4}$	202
X. C.	Male	21	5	8	154	$11\frac{1}{2}$	$8\frac{1}{2}$	$8\frac{1}{4}$	*$34\frac{1}{2}$	27	$14\frac{1}{2}$	$14\frac{5}{8}$	206	51	257	105	140	245	$6\frac{1}{4}$	$7\frac{3}{8}$	6	6	$6\frac{1}{4}$	$6\frac{1}{2}$	$4\frac{1}{8}$	$2\frac{1}{2}$	$9\frac{7}{8}$	Right	$2\frac{6}{8}$	202
I.	Male	87	5	9	109	$14\frac{1}{4}$	$28\frac{1}{2}$	23	$33\frac{1}{2}$	$27\frac{1}{2}$	$15\frac{1}{2}$	15	253	46	299	163	179	342	8	$8\frac{6}{8}$	$7\frac{1}{2}$	$6\frac{3}{8}$	$6\frac{7}{8}$	$6\frac{1}{2}$	4	$2\frac{1}{2}$	$9\frac{6}{8}$	Left	$2\frac{6}{8}$	224
N. H.	Male	22	5	10	133	—	—	—	†$30\frac{1}{2}$	$25\frac{1}{4}$	$13\frac{1}{2}$	$14\frac{1}{4}$	219	37	256	110	138	248	8	$8\frac{3}{8}$	$7\frac{6}{8}$	$5\frac{3}{8}$	$5\frac{5}{8}$	$5\frac{7}{8}$	$3\frac{1}{4}$	$2\frac{1}{2}$	$9\frac{1}{4}$	Same	$2\frac{3}{4}$	233
P.	Male	40	5	10	98	$13\frac{1}{2}$	45	$35\frac{3}{4}$	$31\frac{3}{4}$	$27\frac{3}{4}$	$14\frac{1}{4}$	$16\frac{1}{4}$	271	50	321	144	205	349	$7\frac{5}{8}$	$9\frac{1}{8}$	$7\frac{5}{8}$	$6\frac{1}{4}$	$6\frac{7}{8}$	$7\frac{1}{8}$	$4\frac{1}{4}$	$2\frac{1}{2}$	$9\frac{7}{8}$	Left	$2\frac{1}{8}$	240
A.	Male	28	5	10	132	$13\frac{3}{4}$	45	$33\frac{1}{4}$	$35\frac{3}{4}$	31	$16\frac{3}{4}$	17	241	63	304	132	163	295	$7\frac{1}{8}$	$7\frac{1}{2}$	$7\frac{1}{2}$	$6\frac{7}{8}$	$6\frac{7}{8}$	$7\frac{1}{2}$	$4\frac{3}{4}$	$2\frac{7}{8}$	11	Left	3	238

* Alive, 33. † Alive, 33.

77.—Those who are curious may consult this last Table upon a variety of subjects in connection with the chest and the stature, points most valuable to the medical practitioner. I shall here only mention one or two of the most important in connection with our subject.

78.—The cases are arranged according to their height; the shortest placed first and the tallest last, with a regular gradation between. It will be seen that the cubic contents of the chest in no way correspond with the height, therefore the increasing quantity of air, which I term the vital capacity, is *not* regulated by the size of the chest. The shortest man, only 5 feet 4 inches, has a thorax of 335 cubic inches, and the three tallest men, of 5 feet 10 inches, a mean *absolute* capacity of 297 cubic inches, being 38 cubic inches *less* than that of the man 6 inches shorter.

This Table is more valuable, from my having had an opportunity of examining two men when living, and a few days subsequently, of taking a cast of their chests an hour after death. The one cast is marked X. C., 5 feet 8 inches, the cubic measurement of which I found to be 245 cubic inches, and his vital capacity, determined when alive, was 202 cubic inches at 60°, which, if calculated at 98° degrees as the supposed temperature of the body, brings it to about 218 cubic inches; but there was the commencement of tubercle in his lung, or he would otherwise have breathed (with the corrections for temperature) about 235 cubic inches; only 10 cubic inches short of the whole space allotted for these organs.

79.—The next case was a man still taller, marked N. H., whose height was 5 feet 10 inches; the cubic contents of his chest I found to be 248 cubic inches, while his vital capacity (making corrections for temperature) was 251 cubic inches, at 98°—three inches *more than the whole space of the thorax* appropriated for the heart and lungs.

80.—I may here introduce the statement of a curious circumstance, in connection with this last case, which will be found to militate against a generally-received opinion.

It will be recollected that the vital capacity is obtained by

a maximum movement of the boundaries of the chest, and it is believed that this thoracic movement is impeded by adhesions between the pleuræ. In this case I can affirm, that though the mobility of his chest exceeded the whole space or cubic contents of that cavity, there was not one square inch of the pleuræ but what was *firmly united.* His lungs in other respects were healthy in structure, and his vital capacity scarcely diminished.

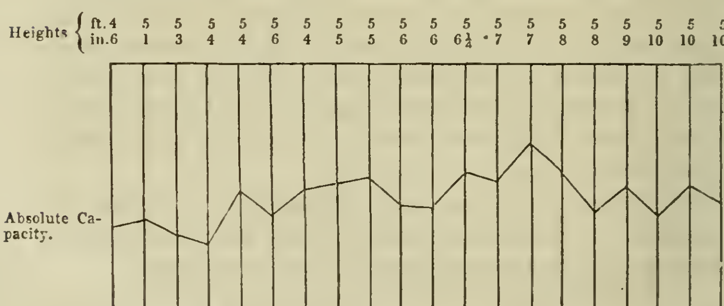
81.—From this it would appear that adhesions of the pleuræ do *not* prevent the freedom of the respiratory movement, and I think we may here generalise from a single case. I believe the movement of the ribs in respiration is *so* closely followed by the lungs, that a perfect union between the two does not interfere with this function.

82.—The largest chest amongst these casts is that marked S.: the height of the man was only 5 feet 8 inches, yet he possessed an *absolute* capacity of 457 cubic inches, and according to his conformation and general dimensions his vital capacity might be expected as 202 cubic inches: this is not one half of the absolute capacity.

The range of the absolute capacity of the cases from whence these casts were taken, I have described by a curve on Diagram 5.

Diagram 5.

The *Absolute Capacity* of the thorax of 20 subjects—6 females and 14 males, in the same order as given in Diagrams 7 and 8, placed in gradation, the shortest first, and the tallest last, on the right.



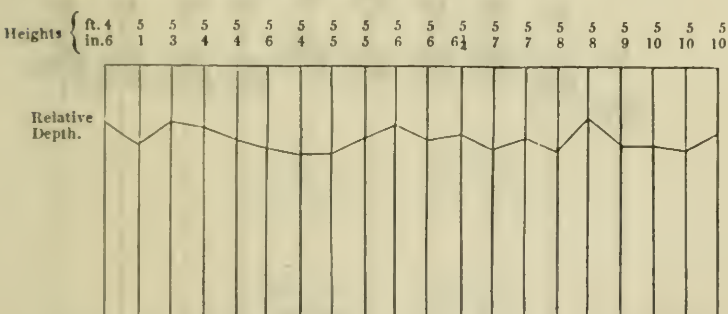
The 20 perpendicular lines are to represent the 20 cases, the shortest placed on the left hand side, and the tallest on the right, and the rest arranged in their proper gradation, with their respective heights marked at the top.

83.—The curve passing over these 20 lines represents the *absolute* capacity of the thorax, which, it will be seen, is very irregular. Whereas, had the *vital capacity* been delineated, it would have been nearly in one continuous ascent, therefore we may safely say the absolute capacity of the chest and the vital capacity do not appear as yet to have any direct relation.

84.—I have frequently been asked if the depth of the chest did not increase with the height of the individual. I find this not to be the case, as the casts will illustrate. The casts N and A (see Table L.) are taken from men of 5 feet 10 inches, and the cast Z from the shortest man, whose height was 5 feet 4 inches : the depth of the taller man's chest is about 8 inches, and that of the shortest man 10½. Therefore the depth of the thorax has nothing to do with the increasing vital capacity which so corresponds with the stature. (See Table L. columns 19, 20, 21.)

Diagram 6.

The *Relative Depth* of the thorax of the 20 cases given in Diagram 5. The heads are on the same plane with each other, and are placed in the same gradation as in Diagrams 5, 7 and 8.



On Diagram 6 I have drawn a curve, to represent the depth of the chest of these 20 cases; the heights, as in the last

Diagram, are arranged in gradation: this curve also is nearly as irregular as the curve of the absolute capacity given in Diagram 6. There is no apparent sinking of the curve as it passes from left to right, which would be the case did the depth of the thorax increase with the height of the individual. In this Diagram the heads of the cases are all supposed to be on a plane with each other. The respective heights are given at the head of each of these Diagrams.

85.—On Diagrams 7 and 8, I have given a view of the relative *breadth* and *depth* of the thorax in these 20 cases, in relation to their stature, supposing the cases to be standing on the same plane: these also are arranged in gradation, the shortest case placed on the left hand, increasing progressively to the tallest on the right hand.

The first six are females, and the rest males. It will be observed that the relative size or section of the chests of the last five men in Diagram 8, whose height is from 5 feet 8 inches, to 5 feet 10 inches, is smaller than the six preceding men, whose heights range from 5 feet 6 inches, to 5 feet 8 inches.

Diagram 7.

The internal depth and breadth of the thorax, in proportion to the stature, of six females and four males.

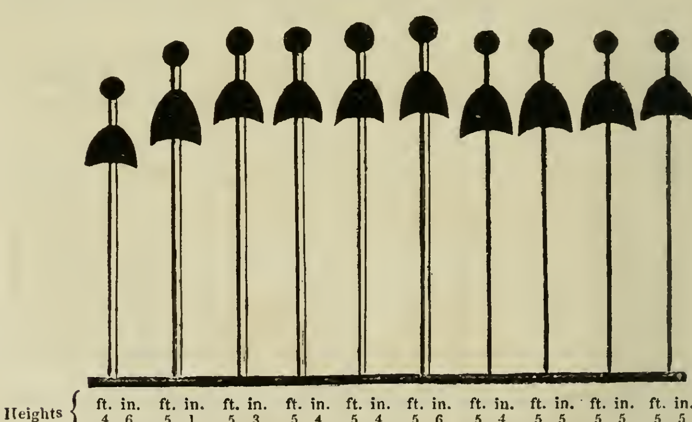
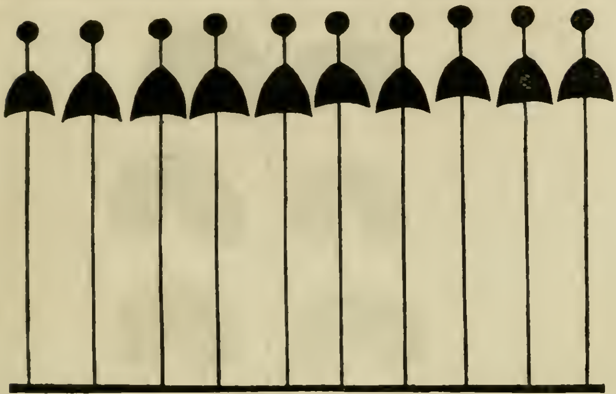


DIAGRAM 8.

The same measurement as in Diagram 7, of ten males.



Heights.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.	ft. in.
	5 6	5 6½	5 7	5 7	5 8	5 8	5 9	5 10	5 10	5 10

This is sufficient to prove, that omitting the effect of mobility, the absolute capacity itself does not correspond with the vital capacity.

DIAGRAM 9.

Sections of the chest at the base, six females and four males.

Area in sup. in.	Heights. ft. in.			Heights. ft. in.	Area in sup. in.
39	4 6	E	D	5. 1.	30
30	5 3	K	V	5 4	38
36	5 4	G	M	5 6	36
41	5 4	Z	F	5 5	36
53	5 5	H	T	5 6	47

Diagram 10.

Section of the base of the chest of ten males.

Area in sup. in.	Heights. ft in.		Heights. ft. in.	Area in sup. in.
41	5 6	L — B	5 6¼	56
44	5 7	C — S	5 7	57
43	5 8	O — X	5 8	51
46	5 9	I — N	5 10	37
50	5 10	P — A	5 10	63

86.—The two Diagrams 9 and 10 are sections of these chests as reduced from the size of life, with their superficial inches marked opposite each: the diameters of these vary in every possible manner, and bear no relation whatever to the height or vital capacity; the heights of the cases from whence these were taken are also attached.

87.—In the last column of Table L. I have affixed the vital capacity obtained from persons of the same height and weight, which may be taken as a fair standard of the supposed vital capacity of these cases.

88.—Many other measurements are given, as the length, breadth and depth of the thoracic cavity, together with other cubic and superficial measurements, the difference between the right and left sides of the chest, &c., all of which are interesting for examination, and to which the curious may be referred.

89.—Having now demonstrated that there is a great difference in the vital capacity of men, and shown what it does *not* depend upon, I will proceed to consider what *is* the cause of this difference.

90.—THIRDLY.—*Of the respiratory movements, and mobility of the chest.*—I am quite at a loss to explain why height governs, or why a relation exists between the amount of air expelled, and the stature. It is well known that the difference of height is chiefly regulated by the length of the legs; I found by direct experiment upon men (between 5 and 6 feet), that whatever be their standing height, their sitting height is on an average 3 feet.

One man of 6 feet and $\frac{1}{2}$ an inch standing, sat only 2 feet $11\frac{3}{8}$ inches; while another of 5 feet 6 inches standing, sat 3 feet high; and therefore the standing height does not appear to correspond with the sitting height, or the length of the body with the length of the trunk.

91.—I will introduce a case I examined, which is here sketched.

DIAGRAM 11.

The relative height of two persons standing.

Diagram 11.

The relative height of the same persons sitting.

Diagram 11 represents two men of the same age, standing and sitting. A, stood 4 feet $4\frac{1}{2}$ inches, B, 5 feet $9\frac{1}{2}$ inches. A, sat $35\frac{1}{2}$ inches, and B, $35\frac{1}{4}$ inches; the circumference of their chests were the same. The weight of A, was 7 stone $2\frac{1}{2}$ lbs., and B, 10 stone 3 lbs. The vital capacity of A, was 152, B, 236 cubic inches. Therefore, the man who sat the *shorter*, could breathe 84 cubic inches more than the man who sat rather taller. The mobility, or expanding power of the chest of the little man, was 3 inches, and that of the taller 4 inches. I have examined other cases with the same result, so that I am inclined to believe the length of the trunk of the body has little to do in regulating the vital capacity.

92.—As the mere length and breadth of the chest has little to do in affecting the vital capacity, we must look to the mobility, or range of movement of the boundaries of the thorax.

It is this mobility which I consider governs the vital capacity, to examine which I had recourse to the following experiments upon respiratory movement.

93.—The shadows of various persons were traced under a strong light, during the different stages of respiration.

94.—The present opinion of the respiratory movements, as described in physiological works, is given in Diagram 12.

Diagram 12.

Of the respiratory movements, as hitherto described.

Let the black continuous line represent the ordinary state. In deep inspiration, it is seen, the chest is chiefly enlarged by the action of the diaphragm, contracting and becoming more horizontal, assuming the position of the broken line; in this manner augmenting the cavity of the chest vertically. At the same time the sternum and abdomen advance outwards, as shown by the dotted line.

95.—This I have found *not* to be the case, although I have examined a number of persons.

96.—The following opinion appears to me more correct. Let me direct attention to Diagram 13, where I represent the tracing of a well-made young man.

Diagram 13.

Respiratory movements.

Deep Inspiration, dotted line.
Ordinary state, continuous line.
Deep expiration, anterior margin of the shade.

97.—The back is supposed to be fixed, in order to throw forward the respiratory movement as much as possible; the outer black continuous line in front is the ordinary quiescent state. This line will be observed to be thicker over the abdomen than elsewhere; this represents the ordinary breathing movement. The anterior margin of this line is the boundary of the ordinary *inspiration,* and the posterior margin the limit of the ordinary *expiration.* It will be observed, this line is thin over the chest, there being over that region, in men, little or no movement in ordinary breathing.

98.—The healthy ordinary breathing movement in men is so remarkably small over the region of the chest, that I was

inclined for some time to believe the movement of the ribs was altogether accidental. By a delicate instrument, I measured the costal movement in health, and found it not to exceed from two to four-tenths of a line, so that, to number the respirations, as has been done in every case (examined by the Spirometer), my hand rested (unconscious to the observer, as if feeling his pulse,) on the abdomen, it being not possible to count the breathing movements, by resting it over the region of the chest.

99.—The *ordinary breathing* movement is therefore abdominal, caused by the descent of the diaphragm pushing out the abdominal viscera.

100.—The *deep inspiratory* movement is not so, but quite the contrary; the sternum *advances* while the abdomen *recedes*; this movement is indicated by the dotted line (Diagram 13). We may conceive, by the annexed figure, an axis below the sternum, upon which this movement turns.

101.—The chief enlargement of the thoracic cavity in deep inspiration is therefore made by the ribs and *not* by the diaphragm, as is commonly believed.

102.—So much is the abdomen drawn in, that in this deep inspiratory effort, a portion of the line of the ordinary breathing (Diagram 13) is *external* to that of the *deep* inspiration; consequently the position of the diaphragm, in deep inspiration, most probably is not flattened, or lowered, to the extent generally believed; and it appears to me a matter of great doubt whether the diaphragm in this act descends at all, as it is evident all that space between the line of ordinary breathing and deep expiration, situated below the sternum, may be considered as just so much space deducted from the abdominal cavity, which tends to induce a movement in this great effort *diametric* to that of the descent of the diaphragm.

103.—There can be no doubt that the circumference of the thorax is increased, and therefore the diaphragm must in like manner extend its borders; but I think it quite possible that this may be done without the arch being lowered.

DIAGRAM 14.

Dimensions of the diaphragm in three stages.

C, ordinary state. B, spread out. A, completely extended. E, relative difference between inspiration and expiration.

A In. 133

B 110

C 40

E 101 outside. 74 inside.

The diaphragm is a large muscle, doubled on itself, to an extent that might allow for this. I have given a section of a chest on Diagram 14, fig. C. The superficial measurement of this is 40 square inches; the figure B, next above, is the same spread out, which is extended to 110 square inches, nearly three times the area of the former figure: even in this condition the centre is quite free, and not upon the stretch, though the circumference is so. To obtain the full measurement, I slit up the sides, as represented in the figure A above, and which gives an increase of 22 square inches, making altogether 133 square inches; even then I could not spread out the entire of this arched muscle. This was the diaphragm of a man of 5 feet 6 inches, with an exceedingly small chest, 29 inches in external circumference, whose vital capacity

might not be expected to exceed 188 cubic inches. I do not believe that in his extreme thoracic expansion he could increase the external circumference (and that chiefly on the anterior part) more than two inches, which would scarcely lower the arch of his diaphragm by the mere extension of its borders.

104.—These two inches of mobility of the chest must not be considered like an increase of two inches, equally, to the circumference of a regular circle. The dorsum part of the chest yields in a much less degree than the anterior portion; all that part corresponding to the angle of the ribs, situated on either side of the spine, (fig. c, Diagram 14,) cannot be expected to increase its borders like the anterior boundary of the same figure.

105.—I represent by Diagram 15 the exact outline and section over the nipples of the living chest of the same figure as given on Diagram 13, in three stages: the ordinary, the deep inspiration, and expiration.

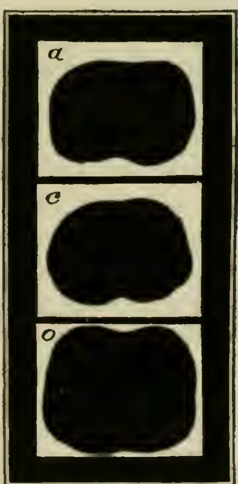
Diagram 15.

Relative difference in the three stages of respiration.

Ordinary. 80 inches.

Expiration. 74 inches.

Inspiration. 101 inches.



106.—The mobility of this chest, or difference between ex-

treme contraction and dilatation, was 5 inches, a range by no means common.

107.—I have given these sections in three squares (Diagram 15) of the same size, that the eye may judge of the relative difference and peculiarities in the three stages of respiration. The highest figure, *a*, is the ordinary state, the superficial extent of which is 80 square inches ; the centre figure, *c*, extreme contraction, or complete expiration, presenting an area of 74 square inches ; and the lowest figure, *o*, that of extreme expansion, measuring 101 square inches. With this mobility the man in question could breathe out 305 cubic inches of air. From this it appears, that with a mobility of 5 inches there was a corresponding increase of 27 superficial square inches to the thoracic cavity at its base ; and taking the minimum area of the chest at 74 square inches, the mobility to it, is in the relation of about 1 to 3. It is curious to observe that in the measurements of the diaphragm given in Diagram 14 there exists also a relation between the minimum area of the chest to that of the stretched out diaphragm, as 40 to 110, or about 1 to 3.

This may be accidental, but the subject appears so striking as to deserve notice.

108.—But to return to Diagram 13 ; having described the ordinary and deep inspiration, I will just refer to the line of extreme *expiration*, or thoracic contraction, which is indicated by the margin of the shade on the anterior portion of the body. This act appears to be a general compression of the whole anterior part. It may be observed that at the lower third of this line of deep contraction, the abdomen is as much pushed out, as the same part is when under the effect of deep inspiration : this is not so in all cases. It is difficult to say what may be the position of the diaphragm in this state of deep expiration.

109.—Diagram 16 represents the same movements in the sitting position with the back fixed ; it will be seen the abdomen still recedes in the deep inspiration, posterior to that of the ordinary state. The continuous line is the ordinary

state; the broken line the deep inspiration; and the margin the deep expiration.

Diagram 16.

Of the respiratory movements with the back fixed.

The dotted line, deep inspiration.
The continuous line, ordinary state.
The margin of the shade, deep expiration.

110.—When the back is free, as in Diagram 17, the whole body of the man, in the deep respiratory efforts, is altered from the head to below the knees; it would be difficult here to say what muscles in the body are *not* concerned in measuring the vital capacity. The continuous line is that of inspiration; and the broken line that of expiration. The head is protruded and lowered in the deep expiration; raised and thrown back in deep inspiration. The body is *lowered* or shortened in expiration. A contrary opinion has been expressed; but having examined now upwards of 1500 cases, I

feel warranted in coming to this conclusion: I have seen some extreme cases of the body lowering in deep expiration one-third of its height.

Diagram 17.

Respiratory movements standing.

Dotted line, expiration.

Continuous line, inspiration.

111.—I will now direct attention to the back view, under these three conditions—the ordinary, and the two extreme states of respiration.

Diagram 18 exhibits these respiratory stages; the continuous black line in the middle is the ordinary state; the upper broken line the extreme inspiration; and the lowest dotted line the deepest expiration: this strikingly exhibits how much the upper part of the chest and shoulders is raised and lowered, while the *lateral* alteration is very inconsiderable.

DIAGRAM 18.

Respiratory movements.—Male, front view.

Inspiration, broken line.
Ordinary, continuous line.
Expiration, dotted line.

112.—From these experiments on the thoracic enlargements in healthy men with the back fixed, it appears that the

Ordinary inspiration is chiefly performed by the diaphragm, and slightly by the ribs.

Extreme inspiration by the ribs elevating and throwing forward the sternum, drawing in the abdomen, increasing the antero-posterior diameter of the chest much, and the lateral diameter but little; the descent of the diaphragm in this act is questionable.

Extreme expiration, by a general compression, approxi-

mation and lowering of the ribs, and a receding or flattening of the whole anterior part of the body.

113.—*Of the respiratory movements in females.*—In Diagram 19, I give a tracing of a female figure, supposed by artists to be of perfect shape.

DIAGRAM 19.

Respiratory movements.—Female.

Inspiration, dotted line.
Ordinary, continuous line.
Expiration, anterior margin.

The three stages of respiration are delineated in the same manner as before; the extreme respiratory movements are the same as in men, as shown by the dotted line and the margin of the shade; the dotted line that of deep inspiration, and the margin of the shade that of deep expiration, but the intervening state, the ordinary movement, is not the same.

The continuous line shows this, the outer margin of which points out the ordinary inspiratory limit, and the inner margin of the same line the expiratory one.

It will be observed, the ordinary breathing movement here is chiefly over the sternum, and a more limited movement over the region of the abdomen : this is the chief peculiarity of breathing between male and female. The heaving of a woman's chest is very perceptible, even when in her full attire.

114.—I cannot account for this ; I much question whether their peculiar costume is the cause of it. I examined 24 girls, between the ages of 11 and 14, who did not wear any tight dress, and I found in them this same peculiarity of ordinary breathing. So slight was their abdominal movement in ordinary breathing, that I could not number their respirations, but by placing my hand over the sternum.

It may be possible that this costal breathing is a provision against those periods when the abdomen contains the gravid uterus. (?)

115.—The front view of the female respiratory movements are given in Diagram 20, which will be seen are the same as those of men—a limited lateral enlargement, with a considerable elevation of the shoulders. The continuous line is the ordinary state, the upper and broken line deep inspiration, and the lower dotted line that of deep expiration; the body is also lowered in expiration.

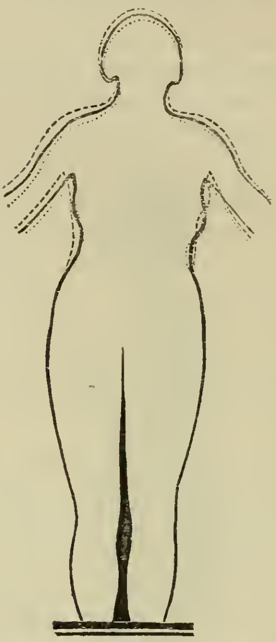
116.—I would wish to make one remark here upon observing the respiratory movements.

When examining a patient in a recumbent position, the breathing movements oftentimes appear more apparent, but this must be received with caution, because, in this state the back becomes fixed, and the previously divided motion is now all thrown forward. I believe it is in consequence of this dorsal movement being so impeded in the horizontal position, that patients labouring under dyspnœa are led to prefer the erect position, which allows of a greater mobility of the thorax than the recumbent, and hence a greater supply of air is obtained for their well-being.

DIAGRAM 20.

Respiratory movements.—Female, front view.

Inspiration, broken line.
Ordinary, continuous line.
Expiration, dotted line.



117.—Having now given a brief outline of the respiratory movements, I must recall the attention to the vital capacity.

We have seen that this corresponds with the height, and not with the absolute capacity of the thorax: why is this the case? I confess myself as much at a loss to explain it as I was the first day I commenced the research. I believe the vital capacity is mathematically commensurate with the range of mobility or thoracic movement; but why the mobility increases in arithmetical progression with height, which appears is chiefly dependent on the length of the limbs, and not on the length of the trunk of the body, I am incapable of explaining. So completely is mobility, and consequently the vital capacity, affected by stature, that a man will breathe in

different positions different quantities of air: thus, standing, I blow 260 cubic inches; sitting, 255; and when recumbent, (supine) 230, (prone) 220; position making a difference of 40 cubic inches.

These positions affect the mobility, and the Spirometer detects this effect more correctly than by any other system I have seen adopted.

118.—The ordinary breathing movements are so small and so much under the control of the will, that I never could gather much by instituting direct measurement from without, to determine the thoracic mobility.

I have attempted to determine the *ordinary* breathing movement by other means, well adapted for minute measurement, and even when the body was fixed behind, so as to throw all the motion forwards, yet I could not bring it to that perfection necessary for diagnosis. Nor do I think this movement can be measured from without when the whole body is free, because the mobility over the whole thorax becomes divided: we have then no fixed point to measure from, and that too, when the thoracic movement is so compound, as to partake, at the same time, of both an upward and lateral motion, *neither* of which can be estimated when measuring the advancing movement. Though I believe an instrument for this purpose has been constructed, yet I have not seen any *series* of experiments detailing what is this law of expansion, either in health or in disease, nor what relation it bears in different persons of different physical development, which tabular arrangement I would rather examine before I can believe otherwise.

119.—FOURTHLY. *Inspiratory and expiratory muscular power.*—Various methods have been adopted by observers to measure the muscular power of man.

Whenever the muscular power to be measured is determined by lifting, pushing, drawing, or striking, I imagine the *weight* of the individual will interfere with the result, and modify the correctness of such conclusion.

I conceive it a very difficult subject to determine the immediate power of a man. The force which a man may exert with his arms may be very considerable, yet that man may not be what is termed a strong and healthy man. It is well known amongst prize-fighters, that men strike with very different power. I examined a small-made man of this class, who complained of never enjoying health, and always feeling weak, yet the blow from this man's arm was likened by his class, "*unto the kick of a horse;*" and I have examined muscular-looking men who were evidently weak men in constitution; and others will perform feats of great strength, and yet look by no means strong.

120.—I consider power in man of two kinds; one, involuntary and present in a dormant or latent state, but which will supply an individual as he needs it, under hardships and fatigue; the other is suddenly brought forth at the command of the will in a remarkable degree, as in performing feats of great strength, but which will not support him under long and continued hardships.

What this is dependent upon I am unable to say. I was, however, desirous of making an attempt to measure this voluntary power. With a view of further testing the health of individuals, I constructed an instrument for this purpose, which the Fellows have had an opportunity of examining.

121.—The resistance here afforded to measure the true respiratory power is a column of mercury.

The dial plate of the instrument in question is divided, to mark the inches and tenths of mercury so lifted; the communication is made by a peculiar adaptation to the nostril, that the true *respiratory muscles* only may be tested: were it by the mouth, the muscular act of smoking, or suction by the tongue, would interfere and render the observation useless.*

* "A much greater force is required, in order to produce a blast of a given intensity with a large pair of bellows, than with a smaller pair; and, for the same reason, it is much easier to a glassblower, when he uses a

Dr. Hales first mentioned this method of examination. He remarks,* "A man by a peculiar action of his mouth and tongue may suck mercury 22 inches, and some men 27 or 28 high; yet I have found by experience, that by the bare inspiring action of the diaphragm and dilating thorax, I could scarcely raise the mercury 2 inches." Had Hales examined more cases, he would have found that 2 inches was *below* the ordinary power.

122.—Two efforts are measured by this instrument, the extreme inspiratory and expiratory powers. One part of the dial is marked 0, from whence the two forces are calculated; certain words are marked on the plate, their position having been determined by 1500 experiments; the words and figures, on the left side, are the figures for *inspiratory* power, on the right, those for *expiratory* power, as follows:—

Power of inspiratory muscles.		Power of expiratory muscles.
Inches.		Inches.
1·5	Weak	2·0
2·0	Ordinary	2·5
2·5	Strong	3·5
3·5	Very strong . . .	4·5
4·5	Remarkable . . .	5·8
5·5	Very remarkable . .	7·0
6·0	Extraordinary . . .	8·5
7·0	Very extraordinary .	10·0

blowpipe, to employ the muscles of his mouth and lips than those of his chest, although these are much more powerful. If we estimate the section of the chest at a square foot, it will require a force of 70 lbs. to raise a column of mercury an inch high, by means of the muscles of respiration, but the section of the mouth is scarcely more than 8 or 9 square inches, and a pressure of the same intensity may here be produced by a force of about 4 lbs."—Young's Lect. Nat. Phil. 8vo, 1845, p. 200.

* Stat. vol. i. p. 267.

It will be observed that the figures on each side of the same word differ in their value, the expiratory side ranging about one-third higher, because the power *manifested* (I do *not* mean power exerted) by these muscular efforts varies in this relation. Thus, a man capable of elevating by his inspiratory muscles 3·5 inches of mercury, may be expected to raise by his expiratory muscles 4·5 inches: the explanation to this will be given in the next head under elasticity, &c. Haller, in his First Lines of Physiology (p. 123), in speaking of this violent effort, says, "By this force, leaden bullets, weighing above a drachm, may be blown to the distance of 363 feet, which force is equal to a third part of the pressure of the atmosphere."

123.—With the instrument in question I have compared these efforts in several classes, and ventured thus to estimate the health of the men employed in different trades, which will be seen to manifest a remarkable difference. The following is a Table of the principal cases.

Letters of reference to the different classes of men given in the next Table.

A.—Seamen.
B.—Firemen.
C.—Metropolitan police.
D.—Thames police.
E.—Mixed class.
F.—Grenadier Guards.
G.—Pugilists.
H.—Draymen.
I.—Horse Guards.
K.—Paupers.
L.—Compositors.
M.—Pressmen.
N.—Mean of Printers.
O.—Diseased.
P.—Gentlemen.
Q.—Mean of the four healthiest classes.
R.—Mean of the whole thirteen classes, except the diseased.

M.—Table of the Inspiratory and Expiratory Muscles of Respiration, in relation to Height.

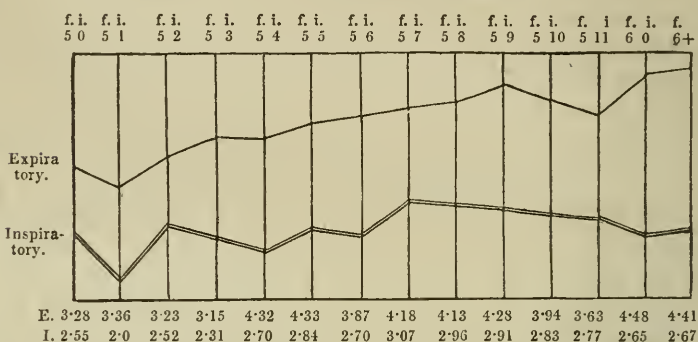
CLASS	0 to 5 ft.			5 0 to 5 1			5 1 to 5 2			5 2 to 5 3			5 3 to 5 4			5 4 to 5 5			5 5 to 5 6		
	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.
A.	3·17	3·41	5	2·20	2·60	1	2·03	3·48	7	2·10	3·74	1	2·18	3·89	9	2·68	4·23	8	2·84	4·25	15
B.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
C.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
D.	2·55	3·28	1	...	...	...	...	...	...	...	...	...	2·70	4·26	6	3·05	4·50	9	2·58	4·34	9
E.	3·00	3·74	1	2·00	3·36	1	2·52	3·25	5	2·31	3·15	5	1·85	2·69	17	2·30	3·05	18	2·40	3·37	16
F.	...	...	...	...	...	...	...	...	...	4·50	5·36	1	...	...	...	4·50	3·10	1	2·70	2·90	2
G.	...	...	...	...	...	...	3·80	1·75	1	2·40	2·41	2	3·50	3·71	1	3·53	5·29	3	3·86	4·75	3
H.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1·30	1·70	1
I.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
K.	1·79	2·45	7	1·46	1·93	3	2·52	2·96	9	2·08	3·30	10	2·30	3·38	21	2·17	3·30	20	1·93	3·13	19
L.	...	...	...	...	...	...	2·32	2·96	3	1·65	2·52	1	2·13	3·23	5	2·17	2·91	4	1·65	2·85	7
M.	...	...	...	2·20	5·00	1	...	...	...	3·35	4·20	1	...	...	...	2·81	4·17	3	2·04	3·27	8
N.	...	...	...	2·20	5·00	1	2·32	2·96	3	2·50	3·36	2	2·13	3·23	5	2·49	3·54	7	1·84	3·06	15
O.	0·82	1·37	5	1·30	3·00	1	1·16	2·14	4	1·00	1·81	4	1·34	2·30	...	0·74	1·00	1	1·25	1·52	9
P.	...	...	...	...	...	...	1·50	2·80	1	2·55	3·00	1	1·77	2·92	6	2·01	2·10	7	1·94	3·21	11
Q.	2·55	3·28	1	...	...	...	...	...	...	...	...	...	2·70	4·32	8	2·84	4·33	12	2·70	3·87	29
R.	2·42	2·95	14	1·80	2·79	6	2·41	3·19	25	2·33	3·36	21	2·21	3·32	67	2·48	3·51	76	2·40	3·58	110

CLASS	5 6 to 5 7			5 7 to 5 8			5 8 to 5 9			5 9 to 5 10			5 10 to 5 11			5 11 to 6 0			6 0 to 6 +		
	Insp.	Exp.	Casse.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.	Insp.	Exp.	Cases.
A.	2·63	3·56	15	2·87	4·15	14	3·11	4·19	9	2·66	3·84	18	2·11	3·76	12	2·61	4·15	6	2·00	4·00	1
B.	3·17	3·95	15	3·02	4·09	15	3·08	4·50	18	2·69	3·33	5	2·40	3·74	1	3·65	6·81	2	2·10	2·80	1
C.	3·07	4·05	4	2·89	4·07	39	2·81	4·10	46	2·92	4·00	23	2·78	3·41	12	2·53	3·23	12	2·75	3·77	8
D.	2·97	4·44	16	3·08	4·31	16	3·05	4·66	11	2·54	4·27	5	2·78	4·45	3	...	...	...	...	...	...
E.	2·31	3·38	21	2·16	3·17	27	2·16	3·50	17	2·41	3·67	15	2·07	2·45	7	2·14	3·08	11	2·77	4·10	2
F.	...	...	...	2·68	3·83	8	2·94	3·89	19	2·23	3·49	18	2·56	3·76	11	1·92	3·17	12	2·46	3·82	14
G.	1·20	6·42	2	3·65	4·61	2	3·70	4·84	1	3·78	4·38	2	3·77	4·89	4	3·25	4·93	2	3·52	4·64	2
H.	2·80	3·55	1	2·73	4·59	3	2·37	4·16	3	4·50	5·43	3	3·21	4·30	6	2·02	3·13	2	3·15	5·00	1
I.	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	2·71	4·81	31	2·68	4·66	27
K.	2·45	3·33	10	1·96	2·71	8	1·87	3·33	9	2·55	3·46	1	1·47	1·67	2	1·61	3·70	4	...	...	...
L.	2·05	3·10	5	2·43	3·22	7	2·83	3·41	8	2·00	2·39	2	...	...	...	1·56	1·91	1	...	...	...
M.	2·10	2·95	3	2·62	2·58	8	1·65	2·05	1	2·95	3·93	3	2·62	3·72	2	...	...	...	...	...	...
N.	2·07	3·02	8	2·52	3·40	15	2·24	2·73	9	2·47	3·16	5	2·62	3·72	2	1·50	1·91	1	...	...	...
O.	0·79	1·70	4	1·67	1·88	7	1·32	1·78	8	0·93	1·60	3	0·88	1·59	3	0·40	2·25	1	1·65	4·02	1
P.	2·35	2·62	12	2·35	3·30	16	2·40	3·30	16	2·74	3·59	7	2·84	3·49	12	3·12	4·94	5	2·38	3·70	4
Q.	3·07	4·18	35	2·96	4·13	70	2·91	4·28	75	2·8[illegible]	8·94	33	2·77	3·63	16	2·65	4·48	45	2·67	4·41	36
R.	2·65	3·65	104	2·65	3·76	163	2·75	3·91	158	2·65	3·79	102	2·67	3·62	72	2·51	4·11	85	2·65	4·17	58

124.—It will be observed from this Table, there is a constant difference between the inspiratory and expiratory power.

DIAGRAM 21.

Inspiratory and expiratory power in healthy cases.



On Diagram 21, I represent by curves their relative position: the upper line is the expiratory power, and the double line below the inspiratory power. The perpendicular lines are the different heights of the cases examined. The chief object of this diagram is to point out the variation between these two powers. The two rows of figures at the bottom are the inches and tenths of mercury elevated (I. for Inspiration, and E. for Expiration.

According to this, at the height of 5 feet 7 inches, and 5 feet 8 inches, the inspiratory power is greatest, and from thence the strength gradually *decreases* as the stature *increases*. The men of 5 feet 7 and 8 inches elevate a column of 3 inches of mercury; this I call a healthy power, and the men of 6 feet about 2½ inches.

125.—Many interesting comparisons may be made by referring to Table M. The "Gentlemen" will be seen to stand very low in power. A gentleman may be considered a "*tolerably good gentleman* of the ordinary stature (5 feet 8 inches) who can raise 2½ inches of mercury by the true inspiratory effort. This may account for the fact why Dr. Hales could not raise more than 2 inches of mercury by this effort.

The expiratory power I do not consider such a test of strength, or, if I may be allowed the term, the "*vis vitæ*," as the inspiratory. The expiratory muscles participate in other duties besides that of mere expiration—the vocation of the glassblower, the trumpeter, the wrestler, the jeweller (blowpipe), and the sailor, especially call these muscles into use, disturbing their natural power. They become oftentimes preternaturally strong. The inspiratory muscles are for supplying us with air, in which act they oppose only a uniform and ordinary resistance to the elasticity of the lungs, ribs, and their cartilages, and do not so conspicuously assist in the varied operations of life, and, consequently, are not subjected to any extraordinary resistance; therefore, in examining the inspiratory and expiratory powers, vocation must be considered, which, should it interfere, the difference is so remarkable as to awaken attention.

I have seen in a wrestler the expiratory power exceed nearly four times that of the natural inspiratory power, which vast preponderance was purely the effect of his favourite amusement.

The diminution of this enormous surplus power may or may not be attended with an alteration in the *vis vitæ*: the question therefore of estimating the health from the *expiratory* power alone, becomes complicated and difficult. The *inspiratory* power is not subject to such changes, it is more uniform, and may remain constant, while the other is oscillating; therefore I am inclined to look for the first intimation of debility from disease in the inspiratory effort, and not the expiratory; the expiratory muscular power may however be taken as a test of health when it exceeds the inspiratory.

126.—This instrument will correctly measure the difference of force produced by the inspiratory and expiratory efforts on the same individual; but when we compare men of different sizes, the question becomes more complicated; then the hydrostatic law of the pressure of fluids must be recollected (144; and note, p. 198).

127.—Fifthly. *Of the elasticity of the ribs, and estimate of the voluntary respiratory power.*—We may consider all animal power under two heads, each possessing specific properties, elasticity and muscular contractility, both of which may be so combined as to produce one common effect.

In measuring animal power, these two operations should be kept distinct, differing widely in their characteristic properties.

128.—Elasticity depends simply on re-action, and restores in a contrary direction the force which had been impressed; the effect produced is commensurate with the amount of the cause, and the re-action can never take place so long as the cause continues to be applied; but immediately that cause ceases, elasticity comes into action.

In muscular contractility the mechanical effect is infinitely greater than the mechanical cause producing it; moreover the *cause* of the force, and the *effect*, operate at the same time, and the re-action surpasses the force of the agent.

Muscular power has excited frequent attention. Borelli* has calculated that the immediate force of the biceps is equivalent to about 300 lbs, and that of the muscles which raise the lower jaw above 500 in man, but in beasts of prey far greater. Young says,† "It is obvious that in muscles of the same kind, the strength must be as the number of fibres, or as the extent of the surface which would be formed by cutting the muscles across; and it is not improbable that the contractile force of the muscles of a healthy man is equivalent to about 500 lbs for every square inch of their section."

129.—A calculation of the elastic power of the body has apparently drawn little attention, and yet it performs a most important and powerful part in the respiratory function, not as a source of power, nor originator of motion, but as a restorer in a contrary direction to the force impressed—an antagonizer to muscular power: thus a power is obtained in the body, and that to an enormous extent, independently of any direct drain upon vital energy.

* De Motu Animalium, 4to, 1710. Ludg. Bat. p. 30 *et seq.*

† Lect. on Nat. Phil. London, 1845, p. 99.

130.—There is probably no function in the body that employs these two forces so powerfully as that of respiration, every inspiration being an act of muscular power, and every expiration that of muscular and elastic power; by the former in the action of the diaphragm and thoracic muscles, and by the latter in that of certain muscles, the elasticity of the ribs and their cartilages, together with the lungs.

131.—The broad difference manifested in my experiments upon the respiratory powers between inspiration and expiration (Table M. 125, 126), was sufficiently marked to induce me to examine into the elasticity of the ribs as the cause of difference. We have seen that the expiratory power is on an average one-third stronger than the inspiratory power, or that it manifests itself as such on the instrument for measuring power.

132.—I believe that this third of increasing difference is chiefly due to the elasticity of the ribs, and not due so directly to muscular force. To determine this point I had an opportunity of examining, after death, two cases under the most favourable circumstances for this inquiry, viz. before the body had lost one degree of its natural temperature.

133.—One was a young man 22 years of age. Weight $9\frac{1}{2}$ st., height 5 ft. 10 in.; his vital capacity was 235 cubic inches at 60°. The *absolute* capacity of his chest was 248 cubic inches; the internal superficial measurement 256 inches; circumference of this chest, alive, over the nipples, in the ordinary state 33 inches, dead $30\frac{1}{2}$ inches. When alive he breathed 235 cubic inches: after death I forced into his lungs certain quantities of air *within* this limit, when the temperature of his body was at 97°, the remains of his own animal heat. It is clear that any force resisting this introduction of air must have been principally due to the elasticity of the ribs and their cartilages, and the lungs, and not to any voluntary muscular power. It will be seen the difference of the size of the chest between life and death was $2\frac{1}{2}$ inches, therefore death was attended by an expulsion of the reserve air, or a complete expiration: this reserve air I calculated to be 70 cubic inches.

134.—By an arrangement I could force in any quantity of air, and measure the power with which it returned, by the elevation of a column of mercury : the following was the result :—

	cub. in.			
Forced in	70	resisting elasticity	1·20	of an inch of mercury.
Ditto	+ 20	ditto	1·25	ditto
Ditto	+ 70	ditto	2·50	ditto

The total quantity of air forced in was 160 cubic inches; beyond this I could not proceed, the lungs having burst on introducing the first portion. I then found it impossible to prevent air escaping, owing to the power of elasticity, and, that, *not* of the lungs, but of the ribs. I repeated this experiment three times, with the same result, the chest always returning with very considerable force to the original position. The total quantity of air forced into the chest will be observed was 75 cubic inches *less* than the quantity he could draw in and expel when alive, which was 235 cubic inches.

135.—The second case was a man of 5 feet 8 inches; weight 10 st. 10 lbs; age 21; vital capacity 200 cubic inches, *absolute* capacity 245 cubic inches, superficial inches of the entire cavity of the chest 256 square inches; circumference of the chest, alive 33 inches, dead 34½. Temperature of body when examined 97° F. Temperature of the air forced into his lungs 63° F. In this man the following was the elastic power of the ribs.

	cub. in.			
Forced in	70	resisting elasticity	1·00	inch of mercury.
Ditto	+ 20	ditto	1·50	ditto
Ditto	+ 90	ditto	3·25	ditto
Ditto	+ 20	ditto	4·50	ditto

136.—The first 90 cubic inches introduced ruptured the lungs, but I continued forcing in the subsequent portions of air, at the same time preventing any escape, so that this may be considered as the elastic power of the ribs and their cartilaginous and ligamentous attachments. From this experiment it will be seen, that this man when alive breathed 200 cubic inches into the Spirometer, and when dead the same quantity was resisted by an elastic power of 4½ inches of mercury; therefore the voluntary effort required to breathe out 200 cubic

inches when alive, must have demanded a muscular power equal to resisting an elastic force commensurate to $4\frac{1}{2}$ inches of mercury, upon every square inch of his chest which was moved or expanded by muscle. This man was muscular and well developed; the other was thin, tall, and not muscular: the two experiments run very nearly the same. I shall place them in juxtaposition.

N.—Table of Costal Elastic Power.

H.		C.	
Cubic inches.	Elastic resistance.	Cubic inches.	Elastic resistance.
	Inches of mercury.		Inches of mercury.
70	1·20	70	1·00
+ 20	1·25	+ 20	1·50
+ 70	2·50	+ 90	3·25
0	0	+ 20	4·50

137.—The geometrical increase of elastic resistance I must leave to the mathematician, and here only venture a remark upon the muscular power exerted to overcome the elastic power. I may also mention, I could not determine any question touching the elasticity of the lungs, as in each case these organs were ruptured by the force applied from within to overcome the elastic power of the ribs; the mean quantity of residual air I exhausted was only 40 cubic inches. There are here also some valuable points to be gained respecting the propriety of insufflation, but this must form the subject of a separate paper.

138.—According to these two last experiments, what shall we say was the muscular power exerted in inspiration during life? For convenience I will take the case of C. in the last Table. In the four stages of inspiration, the elastic resistance was as 1, 1·5, 3·25, and 4·5 inches of mercury. If these inspiratory efforts were the result of equal muscular force, equally distributed over the whole thorax, the muscular inspiratory power

would be easy of calculation. Taking chest C. at 206 superficial inches, it would appear as follows :—

O.—Table of Inspiratory Muscular Power, if equally applied, resisting Costal Elastic Power.

Air forced into chest.	Inches of mercury elevated.	Costal elastic power to be overcome in the sq. in. in ounces.	Total muscular power merely resisting the elastic costal power. in lbs.
cub. in. 70	1·00	7·8	104·4
+ 20	1·50	11·7	150·6
+ 90	3·25	25·3	326·3
+ 20	4 50	35·1	451·9

139.—Under this supposition the man when alive exerted a muscular power in making the deepest inspiration equal to the resistance of 451·9 pounds avoirdupois. This power is very considerable. But this state of things does not precisely exist, because the distribution of muscular fibre and mobility is not equally applied in expanding the chest. Let us look at fig. E, Diagram 14, which is taken from Diagram 13; the portion marked black is the range of mobility between extreme expiration and inspiration. This man could expel upwards of 300 cubic inches of air; and no doubt under the same consideration as the last estimate, the *elastic* resistance may be calculated at nearly 1000 lbs.

140.—The next inquiry is, how far is the distribution of the inspiratory muscular fibre and movement removed from that of being equal in its power and latitude of motion at every point of the chest? This is difficult to answer. In fig. E, p. 188, I have supposed the bodies of the vertebræ to be fixed (but it is most probable no part of the chest is actually fixed): from such figure it appears the lateral movement is little, the anterior movement greatest, and the dorsal the least. It is probable this general statement corresponds to every part of the thorax, and may be safely used.

141.—But what shall be said for a more definite opinion? Shall I venture to allow, in ordinary efforts, one-third of the surface of the chest to be supposed passive, and the other two-thirds equally active in mobility and power? i. e. two-thirds lifted by the inspiratory muscles, and one-third left dormant? I think I am perfectly safe in offering this somewhat rude opinion, as very considerably *within* the mark; let us see what would be the muscular power exerted in making a deep inspiration, in the case of C. Under these circumstances, the elastic resistance may be stated as 301 lbs., or 23 ounces on the inch: this force, at *least*, was to be overcome by muscular power in the act of a deep inspiration, a resistance we scarcely feel. Doubtless when a man dies, the costal elastic force ceases to be in action, the ribs collapse, and residual air only is left in the body; but at every period during life they are antagonised by muscular power, which power must vary with the different quantities of air we draw into the lungs. According to the two cases here experimented upon, one died in a state of perfect expiration, the other not so, but more under a state of full inspiration. This does not militate against our last assertion; the peculiar circumstances of death in this case fully explain this apparent anomaly. From the first case, allowing, as before, one-third of the surface of the chest as not acted upon by muscular power, it may be stated that the different portions of breathing air require the following (muscular) power, merely to antagonise the elastic power of the ribs:—

P.—Table of the Inspiratory Muscular Power exerted to draw Air into the Lungs (corrected).

Different stages of inspiration.		Elastic resistance in ounces on the square inch.	Total lbs. on the chest, or total elastic costal resistance to the inspiratory muscles.
From 1st case	Reserve air	5·6	69·6
	Breathing air	7·8	101·4
From 2nd case	Vital capacity	23·0	301·0

142.—This power I think may be *safely* reckoned as *within*

the mark, for here the elasticity of the lungs is entirely omitted, which no doubt is considerable, but which I have not had an opportunity of estimating.

These cases were small men, with narrow chests, and one of them (the former) slender made, so that they may be taken probably as minimum cases of elastic power. Thus we see the resistance to the *ordinary breathing* force, *independently* of the elastic power of the lungs, was equal to lifting more than 100 lbs. at every ordinary inspiration, and that 18 or 20 times a minute, supposing the "*breathing air*" 20 cubic inches!

143.—*Of the voluntary power of the respiratory muscles.*— The last remarks have been on muscular power, as exerted to overcome costal elastic power, but the respiratory muscles are capable at will of exerting a still greater effort; this I have already shown under the 4th division, on inspiratory and expiratory power (Table M., p. 201).

The calculation of this effort I can only present as an approximation to the truth, but, I am sure, it is a power very extraordinary.

144.—Suppose a man to lift by his inspiratory muscles 3 inches of mercury, what muscular effort has he used? The mere quantity of fluid lifted may be very inconsiderable, (and as such I have found men wonder they could not elevate more,) but not so the power exerted, when we recollect that hydrostatic law, which Mr. Bramah adopted to the construction of a very convenient press. To apply this law here, the diaphragm alone must act under such an effort, with a force equal to the weight of a column of mercury, 3 inches in height, and whose base is commensurate to the area of the diaphragm.* The area of the base of one of the chests now before the Society, is 57 square inches, therefore had this man raised 3 inches of mercury by his inspiratory muscles, his diaphragm alone in this act must have opposed a resistance equal to more than 23 oz. on every inch of that muscle, and a total weight of more than 83 lbs. Moreover the sides of his chest would resist a pressure from the atmosphere equal to the

* See note, page 198.

weight of a covering of mercury, 3 inches in thickness, or more than 23 oz. on every inch surface, which if we take at 318 square inches, the chest will be found resisting a pressure of 731. lbs, and allowing the elastic resistance of the ribs as $1\frac{1}{2}$ inch of mercury, this will bring the weight resisted by the chest as follows :—

Diaphragm	. . . . . .	83 lbs.
Walls of the chest	. . . . .	731
Elastic force	. . . . . .	232
	Total . .	1046

145.—In round numbers it may be said that the parietes of the thorax resisted 1000 lbs. of atmospheric pressure, and that not counterbalanced,—to say nothing of the elastic power of the lungs, which co-operated with this pressure.

I would not venture at present to state exactly the distribution of muscular fibre over the thorax, which is called into action when resisting this 1046 lbs., but I think I am safe in stating that nine-tenths of the thoracic surface conspire to this act.

What is here said of the muscular part of the chest resisting such a force, must not be confounded with a former statement (141), of "two-thirds being *lifted* by the inspiratory muscles, and one-third left dormant," under a force equal to 301 lbs. In this case the 301 lbs. are *lifted,* in the other, nine-tenths of 1046 lbs. are said to be *resisted.*

The glass receiver of an air-pump may *resist* 15 lbs. on the square inch, yet it may be said to *lift* nothing. This question of the thoracic muscular force and resistance, and muscular distribution, is rendered complicate by the presence of so much osseous matter entering into the composition of the chest, which can scarcely be considered to act the same as muscle.

146.—Now it will be seen why the expiratory power is manifested as so much greater than the inspiratory; the elasticity of the ribs is quite sufficient to account for this, and may be

proved in another way. Try the expiratory power (by such an instrument as the one before the Society) with the chest empty, observe the utmost expiratory power, probably equal to $1\frac{1}{2}$ inch of mercury, then inspire deeply, filling the chest; now test the expiratory power, and instead of $1\frac{1}{2}$ inch, it will probably be 5 inches.

This difference, I am inclined to think, is due to two causes:—

1st. The elasticity of the ribs, after deep *inspiration, most* powerfully assists in the *expiratory* act; but when the ribs are more collapsed, their elasticity, though co-operating, is of necessity considerably diminished.

2ndly. The chest, when distended with air, presents points of attachment for muscular traction to a greater mechanical advantage than when it is empty.

This experiment proves the elastic force of the ribs as one source of power in *expiration,* whereas this power opposes the *inspiratory* act (to say nothing of the co-operating power derived from the elasticity of the lungs); therefore, the one-third difference prevailing through Table M., between the inspiratory and expiratory power, is not all due to the actual voluntary power being greater in expiration than inspiration, but due to the interference of elasticity. In other words, the vital energy demanded to produce these two forces, inspiration and expiration, is not equally manifested by any dynamic instrument. It is true, two powers are measured, but we cannot refer these powers to two classes of muscles, when a third and involuntary power co-operates with one class and not with the other, until the influence and distribution of that involuntary power be correctly known. All the power manifested in expiration is not muscular, whereas all the power manifested in inspiration is muscular. Nevertheless, I am inclined to believe that the expiratory muscular power is greater than the inspiratory.

147.—The most extraordinary respiratory power I have known, was the case of a Chatham recruit. The experiment was made, and frequently repeated, by my friend

Dr. Andrew Smith, on whose accuracy I place implicit confidence.

The man's age was 18, height 5 feet 6 inches, weight 10 stone 5 pounds, circumference of his chest 35 inches, vital capacity 230; and his inspiratory power was 7 inches, and his expiratory 9 inches! In fact, he reached the limit of the instrument, and there is reason to believe he could have done more than this. At what shall this man's thoracic muscular power be estimated? According to the last calculation, upwards of 2200 lbs., or nearly 2 tons, must have been resisted. I do not say directly lifted, but resisted *without any* counterbalancing pressure, and two-thirds of this, at least, directly *lifted* by his inspiratory muscles.

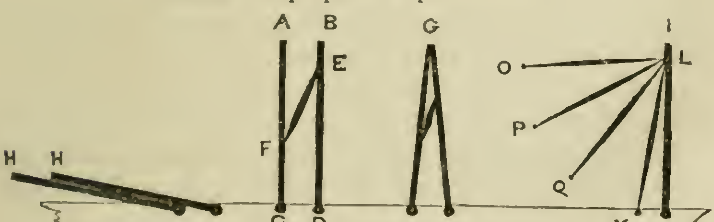
148. — SIXTHLY. *The effect of decussating, diametric, and oblique power, in reference to the function of the intercostal muscles.*

The true function of the intercostal muscles appears still to be involved in obscurity, as no single explanation is admitted without disputation, while laws which are known, admit but of one explanation.

It is not my intention here to enter into the anatomy of the thoracic muscles, nor their specific movements; these must form the subject of a separate communication.

I will but venture to make known what I have found to exist respecting the influence of oblique power directed on parallel bars, and of which effect I have not, according to my understanding, been able to find any account, either in any of the physiological or other works I have consulted.

DIAGRAM 22.
Effect of oblique power on parallel bars.



149.—Let A B, (Diagram 22,) represent two parallel bars, fixed on an axis at C D, which allows of their free rotation, as radii from a centre; imagine a muscle placed obliquely in the direction of E F, let this contract, and what is its effect upon these two bars A B? The answer made to this is, that it will only cause the bars to approximate each other as at G. This is not the case; they will assume the position of the bars H H. Change the direction of the muscle E F, to a contrary course, and the effect will be diametrical to that of H H, drawing the bars to the right side. This cannot admit of disputation.

150.—Let I represent one of the same radiating bars, and K the point or axis where the other bar might be fixed; let L O represent a contracting muscle, the effect of which is to draw the bar *towards the fixed* point O; but instead of making O the fixed point, let P be considered the fixed point, and the effect will be the same, and the same again if Q be the fixed point; but instead of Q, let it be placed at the point K, the axis where the other parallel bar might be placed, and the effect will be still the same, drawing the bar I towards the fixed axis K. But it is not necessary that the muscle L K must contract in its entire extent to draw the bar I towards the point K, two-thirds or more of this long muscle or contracting substance might be made of any non-elastic substance—as wire, wood, or bone, which will still serve to *communicate* the point L to the fixed axis K. Consequently the bars A B are drawn into the position H H, by the muscle E F taking its fixed axis *at* C *and not at* F, to draw upon the bar B at the point E.

151.—Therefore the effect of an intercostal muscle is to draw its rib towards the fixed axis, which is either the head of the rib next above, or to the sternum, according to the direction of the muscular fibre towards that axis.

152.—To determine the action of the intercostal muscles, we have but by common dissection to find the fixed axis. The external intercostal bearing a direction obliquely downwards and forwards, it is evident their action must be to draw each

rib *upwards*, every fibre taking its fixed axis from the head of the rib next above, *therefore every external intercostal muscular lamella* CAN *raise a rib, independently of the lamella next above it.* The eleven external intercostal lamellæ on each side, have, therefore, eleven fixed points, from which they can each *independently* lift a rib; but were all the external intercostal lamellæ to act *equally*, there would be a general rolling motion, over the head of each rib, and the fixed axis then would be the first rib; in this case the head of each rib may be considered as pushed, and not pulled upon in this general rolling motion. This is supposing a costal motion, which I believe rarely exists. The ribs act independently, i. e., costal respiration may be maintained by any pair of ribs. We possess a power of pumping in air with any limited part of the thorax, just as the uterus has a power of partially contracting into the hour-glass shape, therefore I still am disposed to consider the head of each rib as a fixed axis, and that each lamella of intercostal muscle acts *independently* of the lamella next above it.

153.—Though the course of the internal intercostal muscles is in a contrary direction, yet it may be possible that they also are elevators of the ribs in conjunction with the external intercostal muscles, because, though they are diametric in their direction, their fixed point also appears diametric, being to that of the sternum instead of the vertebræ. This requires more consideration, therefore I would wish to defer it at present.

154.—This effect of oblique power as here stated, militates against the opinion that the first rib must of necessity become fixed, for the others to pull upon. Were this the case, what would become of the costal movement when a rib was fractured? All the ribs below the fractured one (granting that the fracture cut off the communication) would be without a fixed point for their intercostal muscles; but allowing every rib to present a fixed axis, costal respiration can be maintained with ease under such circumstances (151).

155.—I have also observed, that in *inspiration* the ribs

diverge from each other, and in expiration they *converge* towards each other—their movement somewhat resembles the action of a lady's fan. Moreover, the ribs may *diverge* from the *direct effect* of intercostal muscular *contraction,* by reason of their gliding movement over each other—a movement common to two or more radii relatively fixed by their end upon a line with each other, just as the bars H H (Diagram 22) must diverge in assuming the position of the bars A B C D, in which act an intercostal muscle must shorten.

156.—SEVENTHLY. *General and practical deductions, in reference to detecting disease by the Spirometer, and the method of its application.*—As the value of every research is in proportion to its usefulness, I hope this subject will be submitted to a careful and impartial examination by others, so that its intrinsic worth may be tested.

It is not easy to determine how extensively the great function of respiration is connected with our bodily health. Boerhaave * appears to have looked upon respiration as a subject of vast importance; he went so far as to say (and I think not without justice), "That scarcely any particle remained in the body which was not more or less concerned in the business of respiration;" "and he subjoins with great justice (says Morgagni†), that the great number of the organs which concur to the performance of this action, any one of which being injured, disturbs the whole function, and creates the highest difficulty in diseases." It is evident Morgagni was impressed with the truth of this opinion, for he devotes many chapters or letters to the diseases which affect respiration.

157.—I shall briefly state my own experience of the Spirometer as a means of diagnosis, that others may have an opportunity of confirming or refuting my conclusions, and shall assign the reasons why I believe its application useful.

* Prelect. ad Inst. 601.

† Morgagni on Seats and Causes of Disease, Transl. by Alexander, 4to, Lond. 1796, vol. i. p. 357.

158.—It will be seen that an investigation has been made upon upwards of 2000 persons, the great bulk of whom are considered as belonging to the healthy classes of society, which will necessarily place us in a position for judging between the healthy and diseased.

159.—The range of observations made upon the diseased, is very limited compared with those upon the healthy; but this, if any thing, makes the test stronger, as one disturbing case, amongst few, is more prominent than one amongst many.

160.—These observations are of two kinds, one measuring *quantity*, and the other *power*: the quantity of air breathed, and the power of the respiratory act—both extreme efforts.

161.—The measuring of quantity or vital capacity is most useful in private practice, the measuring of the respiratory power in selecting men for the public service. To determine the presence of disease and the presence of health requires a distinct series of observations, the duties in civil and military life being very different.

162.—It has been seen (42) that healthy men have a vital capacity which differs according to certain physical variations, while those men physically the same have the same vital capacity.

163.—A difference of vital capacity in men of the same physical development can only be accounted for as the effect of some cause, and that, most probably, disease.

The following Table shows the difference produced by phthisis pulmonalis:—

164.—Q.—Table of the Comparison of Healthy and Diseased Cases.

Phthisis Pulmonalis.			
Early Stage.		Advanced Stage.	
Vital Capacity. Diseased.	Vital Capacity. Healthy.	Vital Capacity. Diseased.	Vital Capacity. Healthy.
Cubic inches.	Cubic inches.	Cubic inches.	Cubic inches.
113	220	59	135
115	173	89	224
105	173	108	254
130	204	72	135
128	220	80	229
120	229	75	251
100	193	34	246
140	246	171	270
100	204	60	237
110	220		
136	229		
135	204		
192	230		
225	300		
145	220		
200	240		
185	230		
218	240		
129	220		
344	434		
220	260		
196	254		

165.—These cases were not from my own diagnosis, but individuals sent to me by others, well skilled in auscultation. One class is said to be in the early stage of that disease, and the other in the advanced stage; consequently there will be seen two ranges of figures under each division, one higher than another. The figures under the *early stage*, on the left, mark the vital capacity of the men as they *were*; those opposite, the vital capacity, as they would have been if healthy; the same arrangement is maintained under the words *advanced stage*.

166.—The healthy range, with the exception of the high-

est, is taken from men of the same physical development, being the mean of some hundreds of observations, the standard of health. The highest case is Freeman, the American, as compared with himself at different times.

167.—It will be seen by this Table, under *early stage*, the men measured a mean vital capacity of 149 cubic inches, instead of 224, an average difference of 75 cubic inches; and, in the more advanced stage, the mean of the diseased 83, instead of 220 cubic inches, a difference of 137. It will be observed there is one case, in the advanced stage, where a man could only breathe 34, instead of 246 cubic inches, a deficiency of 212 cubic inches. The most interesting case is that of Freeman, the "American Giant."

168.—This man came over to England in 1842, and, in the November of that year, trained for a prize-fight; I examined him immediately before his *professional engagement*, when he might be considered in the "best condition." His powers were as follows:—Vital capacity, 434 cubic inches; height, 6 ft. 11¼ in.; weight, 19 st. 5 lb.; circumference of his chest, 47 inches; inspiratory power, 5·0 inches; expiratory power, 6·5 inches. In November, 1844, exactly two years afterwards, he came to town in ill-health. I then examined him in the same way as before, twenty times at various intervals, during which his vital capacity varied from 390 down to 340, and the mean of all the observations was 344 cubic inches, a decrease of 90, or more than 20 per cent.; his respiratory power had decreased one-fifth, and his weight 2 stone. At this time I took him to two physicians well skilled in auscultation, and they both affirmed that they could *not detect* any organic disease. After January 1845, I lost sight of Freeman, and, in the October following, I was kindly favoured with the following account of him from Mr. Paul, Surgeon to the County Hospital, Winchester.

169.—"Freeman was admitted into this hospital on the 8th of October, in an extreme state of debility and exhaustion; he was reduced almost to a skeleton, complained of cough, and was expectorating pus in large quantities. Percussion

on the anterior part of the chest *under the clavicles,* gave, on the right side, a very dull sound; on the left one, much clearer, but still I think less resonant than natural; I made but one attempt at auscultation, but could come to no conclusion, from a rather singular reason,—the ribs were so large, the intercostal spaces so wide, aud so sunk in from the extreme state of emaciation to which Freeman was reduced, that I could not find a level space large enough to receive the end of the stethoscope; could not, in short, bring its whole surface into contact with the chest. Freeman's great debility, and the clearness of the diagnosis from other sources, prevented my repeating the attempt. Freeman, after death, measured 6 ft. 7½ in., and weighed 10 st. 1 lb. On opening the chest, the lungs on both sides were found adhering by their apices to the superior boundaries of the thorax, and studded throughout their substance with tubercles. The tubercles, on the whole, were much less numerous in the right lung than in the left; both lungs were nearly healthy at their base; the tubercular matter gradually increased in quantity towards their upper parts, and the apices of both lungs were almost completely occupied by large cavities partly filled with pus, and capable of containing two or three ounces of fluid each. The heart was remarkably small. The rest of the viscera appeared healthy."

170.—It is very remarkable to see that Freeman lost so much weight; in his prime, he never appeared stout, but strong and muscular. I have been informed, when he first came to England, his weight was 22 stone; he died 10 stone: his natural height was nearly 7 feet, and he died 6 ft. 7½ in.

171.—The Spirometer was useful to me in this case, by indicating the commencement of the disease which ultimately caused his death, and that *before* the usual means availed.

Another good illustration I may relate; a surgeon called upon me when in full practice; he looked in *perfect health,* and said he was so. I measured his vital capacity, and found it 100 cubic inches below the healthy standard; four months afterwards I heard he was ill, and that auscultation had given

evidence of phthisis pulmonalis; a few months afterwards he died of that complaint. This gentleman looked so remarkably well when I first examined him, that I was led to doubt the extent of reliance to be placed upon the Spirometer, but the result entirely removed this doubt.

172.—Another gentleman, holding an elevated position under Government, manifested a great deficiency of vital capacity, and that too when performing his duties; but, within four months, his death took place, and extensive tubercular disease was found in the lungs.

Another case presented itself in one of the men (J. S.) in the Queen's Company, Grenadier Guards; his height was 6 feet 4 inches; his vital capacity only 102 instead of (at least) 300 cubic inches. This man was given to me as a healthy case, but I classed him among the diseased; and, upon inquiry, it was found that he had previously solicited to be relieved from certain physical duties. This is not the only case of a low vital capacity in that regiment.

173.—The last case I shall mention of this kind was a young man of 11 stone, and 5 feet 7 inches high, firm and muscular; his vital capacity was 47 cubic inches below the mark. Within one week of this time I had an opportunity of examining his lungs, and found the left lung at the apex studded with miliary tubercles, the whole not extending beyond a square inch, the entire remaining portion was to all appearance healthy.

174.—I have also had cases of a converse nature. A man who had gone the round of the principal hospitals, looked so ill that I selected him as a case for illustration of phthisical disease, but I found his vital capacity exceeded the healthy standard; I inquired about him eight months afterwards, and was informed that he had returned to work, and was *well*. A jeweller called upon me one day, and said he was told he had consumption, and having a large family, his mind in consequence was much depressed. I found his vital capacity exceed the natural or healthy mean: an explanation of the circumstance relieved the man's mind, and in four months he had so increased in weight and strength, that

all his apprehensions were removed. I will not take up the time of the Society by relating other cases.

175.—These results are no more than might be expected; it is evident if a man breathe 200 cubic inches of air at 98, that in his lungs there must be 200 CUBIC INCHES OF SPACE FOR AIR. It is also certain, that if this man expel at another time from his chest 20 *per cent. minus* that, some *cause* must produce *this effect*. It may be in the lungs or it may not—the Spirometer being a guage in a two-fold sense, a measure for mobility as well as a measure for capacity, because a man cannot breathe without moving.

176.—The respiratory movements I have shown, extend at least over the whole trunk of the body (Diagram 17), and whatever disease attacks this portion of the frame (at least of an acute form), *must* affect this mobility, which can be simply and correctly measured by this instrument. A full meal even will make a difference in the vital capacity, and that inversely commensurate with the capacity of the stomach. I have found a dinner diminish the vital capacity to the extent of 12 and even 20 cubic inches.

177.—In the act of making a deep expiration, we must, of necessity, induce a deep inspiration, during which efforts the whole abdominal viscera have, to an extent hitherto little noticed, been disturbed, and if organic disease be present, the abdominal mobility will be lessened; the converse, also, will hold good—but collateral observations, with the scales, pulse, and general appearance, will show whether the decrease be the result of abdominal or thoracic disease.

178.—The mobility of an ordinary man's chest is about 3 inches; it may be determined by simply passing round the thorax a tape measure over the region of the nipples, then requesting him to inspire and expire deeply; the difference between these two acts will be the "*mobility*." This of itself is an observation which will be found useful, and I can affirm it will be found no less valuable than simple, because it *may* be possible that the mobility is tolerably good even above 3 inches, and the vital capacity bad; in this case, it is probable, the lungs are not sufficiently permeable to air.

179.—The discovery of the seat of disease demands the consideration of a number of circumstances, and every observation forms a link in the chain of evidence leading one way or another; and that observation which can be measured, and is capable of definite expression, at the least expense of mental energy, demands consideration, and will be found to weigh heavily in our prognosis. All we know is gathered from physical observation, through the medium of the senses; physical alterations in the conditions and relations of parts, can only be determined by sight, touch, and hearing, and the more surely these relations of parts are tested, the more definite will be our opinion. If a man breathe into the Spirometer 200 cubic inches, it is neither 199 nor 201 cubic inches; it requires no delicate training of the judgment, nor sense of sight, to come to such a conclusion; therefore, for the purpose of determining a *fact*, the Spirometer is ready and definite, without a long system of education; but by education, I am inclined to think, it becomes an important means of diagnosis.

180.—I can often guess correctly what a man should breathe in this instrument, by looking at him, though through nervousness he may be deficient. I know it to be from mere momentary want of nervous energy, and not from a want of actual capability, or the effect of organic disease.

181.—I do not bring this forward with any view of superseding or precluding other physical means of examination, but, on the contrary, I wish to multiply physical observations, because all the deviations of form and volume of the great cavities indicating some abnormal state, are but too much obscured for want of more extended means of definitely examining them.

182.—It will have been observed that the result of the examination of the diseased cases which I have given, particularly that of Freeman's, was to induce a conviction of the usefulness of the Spirometer in an early stage of disease, more particularly in phthisis pulmonalis; and it may be

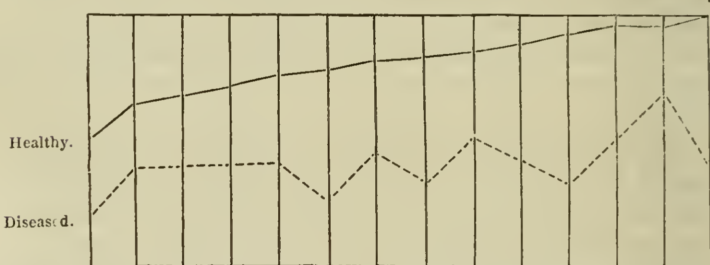
asked, How is it that the difference of the vital capacity should be so great, and the organic disease apparently so little, as not to be detected by the ear? I cannot answer this question with certainty; but I feel strongly disposed to believe that a very small deposition of tuberculous matter will cause a considerable deficiency in the vital capacity.

183.—Writers upon tubercular phthisis lay some stress upon the form and motions of the chest in ordinary and deep breathing; we have seen that in one case (135), the deep inspiration demanded an effort equal to $4\frac{1}{2}$ inches of mercury upon every square inch of the chest, or a total resistance of not less than 300 lbs. to be overcome by muscular power. It is possible that the cachectic condition, in this early stage of the disease, may disable the patient to overcome this resistance, and therefore the vital capacity become diminished by mere want of muscular power.

DIAGRAM 23.

Vital capacity of the healthy and diseased cases compared.

	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f. i.	f.
Heights.	0 0	5 0	5 1	5 2	5 3	5 4	5 5	5 6	5 7	5 8	5 9	5 10	5 11	6
	5 0	5 1	5 2	5 3	5 4	5 5	5 6	5 7	5 8	5 9	5 10	5 11	6 0	6+



Healthy.	143	175	177	189	193	201	214	229	228	237	246	247	259	276
Diseased.	69	100	101	102	103	78	120	98	130	111	96	130	164	102

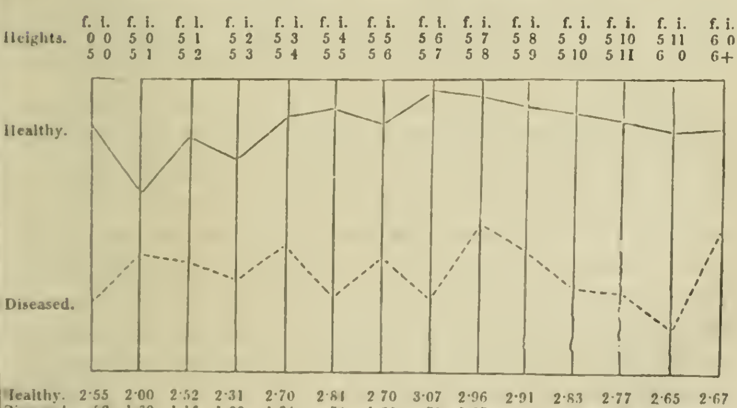
184.—The comparative difference of the vital capacity between the healthy and diseased cases may be seen by the two curves (Diagram 23). The lower dotted one is the vital capacity of the diseased, and the upper one that of the healthy. The difference between the relative heights of these lines from the bottom is equal to the difference between the

actual quantities given by these two orders of persons. The two rows of figures at the bottom are the mean of the observations under each class. The difference is sufficiently strong to merit consideration. The utility of the instrument for measuring the RESPIRATORY POWER, is probably greater to the army-surgeon than to the man in private practice: I have by it frequently detected hernia, and rupture of the membrana tympani. When a hernia is well supported by a truss, it will most likely escape detection.

185.—All that has just been said upon mobility, and its relation to visceral disease, will equally apply to the observations on the respiratory power. The efforts required to move the column of mercury tests the whole trunk. The effort of *inspiration* tested on this instrument producing an attenuation, or rarefaction, of the air within the body, causes an extra pressure upon the whole trunk from *without*, the *expiratory* power (one-third more) in a contrary direction from *within*; and as it is a common rule, that inflammation and disease, in general, are attended with pain on pressure, these, also, may be perceived by the diminished power manifested on the instrument which measures the pressure exerted.

DIAGRAM 24.

Inspiratory power of the healthy and diseased compared.



186.—The difference between the diseased and healthy respiratory power is as widely marked as the vital capacity is by the Spirometer (Diagram 23). This is shown in the same manner by Diagram 24, the lower line being the *power* of the diseased, and the higher that of the healthy. This difference is about one half, as might be anticipated, because weakness is the most prominent symptom of disease. The figures at the bottom definitely show the difference.

187.—During these investigations, the pulse and number of the respirations per minute were taken: the result is contained in the following Tables:—

188.—R.—Table of the Number of Respirations per Minute, in the sitting posture, in 1714 cases.

Number of respirations per minute.	Cases.	Number of respirations per minute.	Cases.	Number of respirations per minute.	Cases.
6	1	20	510	32	6
9	1	21	120	33	0
10	2	22	136	34	1
11	1	23	41	35	0
12	19	24	220	36	1
13	10	25	16	37	0
14	21	26	8	38	0
15	12	27	2	39	1
16	216	28	30	40	1
17	95	29	2		
18	181	30	6		1714
19	70	31	0		

189.—Every one of these respirations was determined without the consciousness of the individual, the observer feeling the pulse with his hand resting on the patient's abdomen, when both the pulse and the inspiration can be numbered. The slowest case was that of 6 per minute: this was a medical gentleman, who had formerly laboured under asthma, but is now quite free from it; since then, his respiration has been thus slow, but deep. The average will be seen as 20 respirations per minute. The following Table is that of the pulse:—

190.—S.—Table of the Pulse per Minute, in the sitting posture, in 1636 cases.

Pulse per minute.	Cases.	Pulse per minute.	Cases.	Pulse per minute	Cases.
48	3	70	57	93	3
49	4	72	44	94	8
50	4	73	58	95	11
51	1	74	32	96	58
52	2	75	11	97	1
53	2	76	118	98	5
54	1	77	2	99	1
56	4	78	38	100	117
57	2	79	7	101	1
58	1	80	315	102	2
59	1	81	3	104	28
60	53	82	28	106	4
62	21	84	167	108	10
63	5	85	2	110	1
64	45	86	25	112	15
65	4	87	2	113	3
66	18	88	88	116	10
67	2	89	16	118	2
68	37	90	31	120	19
69	4	92	76	124	3

191.—The higher range of pulse of course must be attributed to temporary excitement: nevertheless this Table shows that 80 is the prevailing number, and that there are more cases between 80 and 90 than between 70 and 80. The number of respirations per minute are so few and long, that fractions of these movements occur in the minute, though for convenience this is omitted. A deviation from the average by one or two respirations will probably cause a difference of 1800 cubic inches of air passing through the lungs per hour, a quantity too considerable to be overlooked. It therefore becomes necessary to examine into the cause of this increase or decrease, which may exist independently of disease.

It is well known that a sudden difference in atmospheric pressure affects the frequency of the respirations and pulse. Travellers all agree in asserting as a fact, that, when ascending mountains, the diminished pressure accelerates the

respirations and pulsations; here the physical exertion required to attain such heights must interfere, concurring with the diminished pressure to quicken these functions; but M. Gay Lussac, in his celebrated aerial voyage to 7000 yards above the level of the sea (almost the tenth part of the *height* of the atmosphere), though exempt from muscular exertion, remaining almost motionless in the car of his balloon, yet experienced a great acceleration of the respiratory and circulatory functions, along with great thirst, which must be considered as the effects of diminished atmospheric pressure.

Through the kindness of my friend Mr. Potter, of Newcastle-upon-Tyne, mining engineer, I was enabled to make the following interesting experiment upon the frequency of the respiratory functions in the deepest mine of that neighbourhood (South Hetton), in December 1845.

Depth of the mine 1488 feet.

	Barometer.	Thermometer.
At the level of the sea	28·72	39°
At the bottom of the mine . .	30·26	49°
Difference	1·54	10 degrees.

T.—Table of the effect of increased Atmospheric Pressure on the Respiratory Functions in Healthy Men.

	Above.		Below.	
	Pulse.	Respirations.	Pulse.	Respirations.
Mr. P.	65	15	59	16
,, S.	98	20	98	24
,, H.	72	16	68	19
,, L.	90	14	88	15
,, W.	88	18·5	93	22
,, T.	85	18	100	20
Mean	83	16·9	84·3	19·3

This experiment was made with *care*: these men had not undergone *any* previous fatigue, therefore the acceleration in these functions is solely due to an increased atmospheric pressure.

Thus we find that an *increased* as well as *diminished* atmospheric pressure quickens the respirations and pulsations; probably this effect in a little time is diminished.

Independently of our ascending or descending to any considerable height or depth, the atmospheric pressure varies in the same locality. The diurnal oscillation from the effect of the sun producing the atmospheric tides * in this country is probably too small to affect the respiratory functions, but the change of pressure produced by meteorological phenomena is considerable. The annual range of the barometer in this country is nearly 3 inches, a tenth of the weight of the atmosphere (2·95), so that our bodies are exposed to a variation of pressure from meteorological causes alone, exceeding 3000 lbs. (3313·440 lbs.) or 23 ounces on every square inch of the body. Now, according to my experiment in the coal-mine, the sudden augmentation of pressure from an excess of 1488 feet of air was little more than half this, and therefore so much within the limit of natural atmospheric variations as common to our climate. If we take the increased pressure at this depth as the 20th of an atmosphere, the pressure upon these men would be about 11 ounces (11·70 ounces) on the superficial square inch, or a total weight exceeding 1500 lbs. (1611·67 lbs.), which affected the respiratory functions as follows:—

U.—Table of the effect on the Respiratory Functions under the sudden increase of the 20th of an atmosphere in descending 1488 feet.

	Pulse per minute.	Respiration per minute.
Mr. P.	− 6	+ 1·0
,, S.	0	+ 4·0
,, H.	− 4	+ 3·0
,, L.	− 2	+ 1·0
,, W.	+ 5	+ 3·5
,, T.	+ 15	+ 2·0

* "At two periods in the day, at every part of the world, and nearly at the same time of the day, the barometer attains a maximum and minimum as the effect of tides in the atmosphere. If the height of these tides be proportional to the difference between the specific gravity of air and mercury, the morning tide will be about 13 feet, and the evening tide 25 feet."—Thomson, on Heat, p. 240.

The effect on the pulse is irregular; the respirations are universally accelerated, on an average, about one-eighth, a difference which merits consideration.

I believe a difference equal to this may take place as the effect of natural changes in the atmospheric pressure. I have experienced strange sensations and lassitude, &c., under the sudden fall of nearly six-tenths of an inch in the barometer, which once took place within three hours. It is well known how susceptible some persons are to changes in the weather: a day is called heavy, when in truth it is lighter, while we ourselves are heavier; a transient plethora is produced, the blood-vessels become more distended, and the least exertion produces perspiration. Duhamel observed, that in the month of December 1747, the barometer, in less than two days, fell $1\frac{1}{3}$rd of an inch, producing a change on each man of 1400 lbs., which difference was accompanied with many sudden deaths. When the barometer is very high, we generally experience an indescribable sensation of pleasure; the vital energies seem doubled.

Other meteorological causes may interfere concurrently to affect these functions more or less, yet the atmospheric pressure is so easily measured, and so *evidently a modifier* of respiration, that before we determine the breathing movements, as above or below par, the barometer should be noticed.

The effect of *diminished* atmospheric pressure upon the action of the heart and arteries appears more regular than when under an increased pressure. According to Dr. Parrot, a rarified atmosphere influences these functions as follows:—

V.—Table of the effect of diminished Atmospheric Pressure on the Heart's action.

						No. of beats.
Pulse at the level of the sea						70
At 1000 metres, or	3280 feet,	10·29 inches above the level of the sea				75
At 1500	,,	4921	,,	3·43	,,	82
At 2000	,,	6561	,,	8·58	,,	90
At 2500	,,	8202	,,	1·72	,,	95
At 3000	,,	9842	,,	6·87	,,	100
At 4000	,,	13,123	,,	5·16	,,	110

According to this Table the pulse increases 40 beats at the elevation of 4000 metres, or on an average of 1 pulsation per 100 metres (328 feet 1 inch). By the first 1000 metres it rises 1 pulse per 200 metres (656 feet 2 inches).

I am inclined to think this effect is too small to become apparent by diminished pressure from meteorological causes, because, at an elevation of 2000 feet, little more than 600 metres, the barometer, according to Halley's calculation, would stand at 27·86 inches, and I believe this instrument in England never descends to 28 inches, which is an equivalent to an elevation of 1862 feet; therefore a sudden fall of the barometer to its lowest limit would not affect the pulse probably above 2 or $2\frac{1}{2}$ beats per minute: this is even supposing a case of which I believe there is no record.

192.—Many curious combinations may be made from this paper; thus, 1939 men can breathe 431,323 cubic inches, or 31 hogsheads of air, or a little more than $2\frac{1}{2}$ cubic feet for each man per minute, by the greatest voluntary effort.

In this age for promoting ventilation in public buildings, a quantity bearing no relation to this has been thought necessary, which, if not deleterious, has at least been found disagreeable.

I see also that, in the Model Prison, "from 30 to 45 cubic feet of pure fresh air is made to pass into every cell in a minute," "ranging from a temperature of 52° to 60°."*

193.—Another circumstance I have been led to observe, which may be found useful in saving life. We see the vital capacity is, on an average, 225 cubic inches; consequently we possess a power at any time of taking in this stock of fresh air, which may be considered as a reservoir to support life without breathing. Therefore, if we expel from the lungs four or five times the old reserve air which previously remained in the chest, then draw in this 225 cubic inches, or more, according to our vital capacity, and hold the breath, *it will be found we can exist upon this without discomfort* (except for the first few seconds) *three* times as long as any other way. In this way I have seen a man hold his breath two minutes, which (it is said) is the longest time the most expert pearl divers remain under water. "Mr. Brunel, in descending to examine the breach which the river had made in the Tunnel under the Thames, having lowered the diving-bell nearly 30 feet to the mouth of the opening, this was found too narrow to admit the bell, so that no further observation could be made on the state of the shield and other works, which were perhaps 8 or 10 feet deeper. Mr. Brunel therefore, laying hold of the rope, left the bell, and dived himself down the opening; his companion in the bell being alarmed at the length of his stay, now *about two minutes*, gave the signal for pulling up, and the diver, unprepared for the signal, had hardly time to catch hold of the rope which he had let go, and was surprised on coming up to find that so much time had elapsed. On descending again, he found that he could with ease remain *fully two minutes under water!* The reason evidently was, that the atmosphere in the bell being condensed by a column of water nearly 30 feet in height, contained nearly double the quantity of air

* Report of the Surveyor-General on the Construction, Ventilation, &c., of Pentonville Prison, 1844, p. 25.

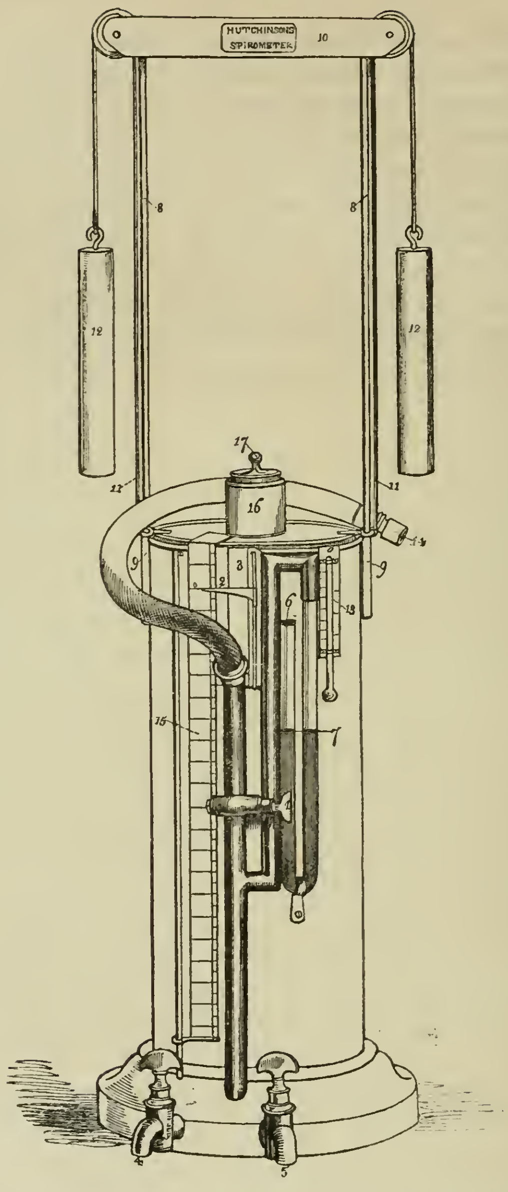
to the same bulk, and thus nearly a double supply in the lungs."*

194.—In cases of fire amidst dense smoke or carbonic acid gas, the after-damp of coal mines, or in draw-wells, a great deal may be done in *two* minutes, or even in one minute and a half, towards rescuing a fellow-creature from suffocation.

195.—I have made some few experiments upon the other divisions of respirable air—as the breathing, the reserve, and complemental airs, but not sufficient, as yet, to warrant my giving any definite statement of their quantities. I directed my attention to that which I conceived would be most useful for detecting disease with the least liability to error.

* Encyclop. Brit, 7th ed. 1842, vol. viii. p. 59, 60.

Diagram 25.


HUTCHINSON'S SPIROMETER
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197.—Directions for measuring the vital capacity of the lungs, together with making other observations.

To prepare the instrument for use.

1. Place the Spirometer about three feet from the ground, on a firm, level table.

2. (See Diagram 25.) Turn off the *water* tap, fig. 4, and turn open the *drain* tap, fig. 5, seen at the bottom of the Spirometer.

3. Pour into the spout at the back, clear, cold water, until it is seen to rise behind the slip of glass, fig. 3, placed above the air-tube.

4. Slide the moveable index, fig. 2, opposite 0 on the scale, and add water until it is exactly on a level with the straight edge of this index. Should too much water be already poured into the Spirometer, draw off by the tap, fig. 4, sufficient to bring the water down to the edge of the index.

5. Pour a little coloured spirit into the bent tube, fig. 6, until it rises in the two legs of this tube about $3\frac{1}{2}$ inches, as represented by fig. 7.

6. Fix the rods, fig. 8, into the sockets, 9, 9, on each side, at the top of the Spirometer.

7. Place upon these rods the cross-head, fig. 10, so that the name of the instrument faces the operator; then pass the two red cords, figs. 11, 11, over the pulleys at each end of the cross-head.

8. Turn off the taps, figs. 5 and 1, then suspend the counterbalance weights, figs. 12, 12, to the red cord.

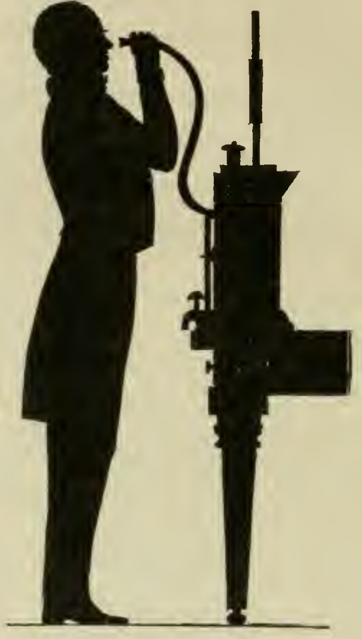
9. Screw the flexible tube, fig. 14, on to the extremity of the air-tube, above the tap, fig. 1. The tube is here turned over the instrument for convenience in the drawing.

10. The small thermometer, fig. 13, may either be attached to the Spirometer on the little hook above fig. 13, or, which is better, hung up in any convenient corner of the room.

The Spirometer is now ready for making an observation.

DIAGRAM 26.

Position of the body in filling the chest before breathing into the Spirometer.



To measure the vital capacity of the lungs.

198.—When the vital capacity of the lungs is to be made (33), let the person to be examined loose his vest, *stand perfectly erect,* with the head thrown well back, as represented by Diagram 26; then *slowly* and *effectually* fill his chest with air, or *inspire* as deeply *as possible,* and put the mouthpiece (fig. 14, Diagram 25) between the lips (standing in the same erect position), holding it there sufficiently tight as not to allow any breath to escape; the observer in the mean time turns open the tap, fig. 1: immediately the patient empties his lungs, and *slowly makes the deepest expiration;* at the *termination* of which the operator turns off the tap, fig. 1, confining in the receiver the expired air,

which part of the Spirometer is now raised out of the reservoir, as represented in Diagram 27, fig. 20.

199.—To measure the quantity of air breathed into the Spirometer, the receiver must be depressed lightly with the hand until the two surfaces of the coloured fluid in the bent tube are brought level with each other, as seen fig. 7, Diagram 25. When these are equal, the straight edge of the index, fig. 2, may be slid to the level of the water, seen through the slip of glass, fig. 3, when it will cut the degree upon the scale which numbers the cubic inches of air breathed from the lungs.* Each degree upon the scale measures two cubic inches. Thus is determined the *vital capacity* of the lungs.

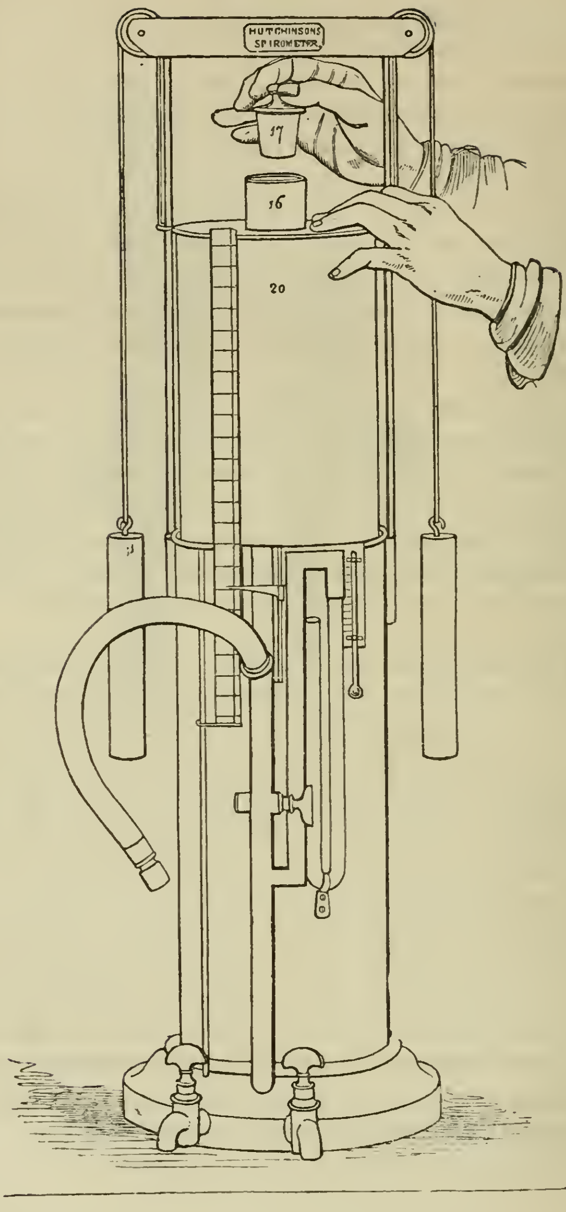
For reference, I here introduce a Table of the vital capacity, in health, for every inch of height between 5 and 6 feet. The column of observation so nearly corresponds with the column in arithmetical progression, that I am inclined to prefer the latter as my guide, because I believe the difference will disappear upon more extended observations. The operator may take either of these columns for his guide.

W.—Table of the Vital Capacity in relation to Height.

Height.	From Observation.	Regular Progression.	Height.	From Observation.	Regular Progression.
ft. in. ft. in.	cub. in.	cub. in.	ft. in. ft. in.	cub. in.	cub. in.
5 0 to 5 1	174	174	5 6 to 5 7	229	222
5 1 to 5 2	177	182	5 7 to 5 8	228	230
5 2 to 5 3	189	190	5 8 to 5 9	237	238
5 3 to 5 4	193	198	5 9 to 5 10	246	246
5 4 to 5 5	201	206	5 10 to 5 11	247	254
5 5 to 5 6	214	214	5 11 to 6 0	259	262

* Instead of using the brass index, a slip of card in the hand is often more convenient for carrying the eye to the degree on the scale.

Diagram 27.



To discharge the air out of the receiver.

200.—Take *out* the valve, fig. 17, Diagram 27, with one hand, while the other depresses the receiver into its original position, taking *particular care*, before returning the valve, fig. 17, into the socket, fig. 16, that the receiver, fig. 20, is perfectly at the bottom, *and* that the surfaces of the fluid in the bent tube, fig. 7, Diagram 25, are level with each other *before* the valve is returned into its socket.

201.—The Spirometer is now ready for another observation.

It will be observed that, after the valve is returned into its socket, and the hands are removed from pressing the receiver down into its place, the coloured fluid in the bent tube will become unequal; that is of no consequence, and will not affect the correctness of the next observation: always recollecting, *immediately* before examining a case, to open the valve and press the receiver perfectly down, *previous* to returning the valve, as already described.

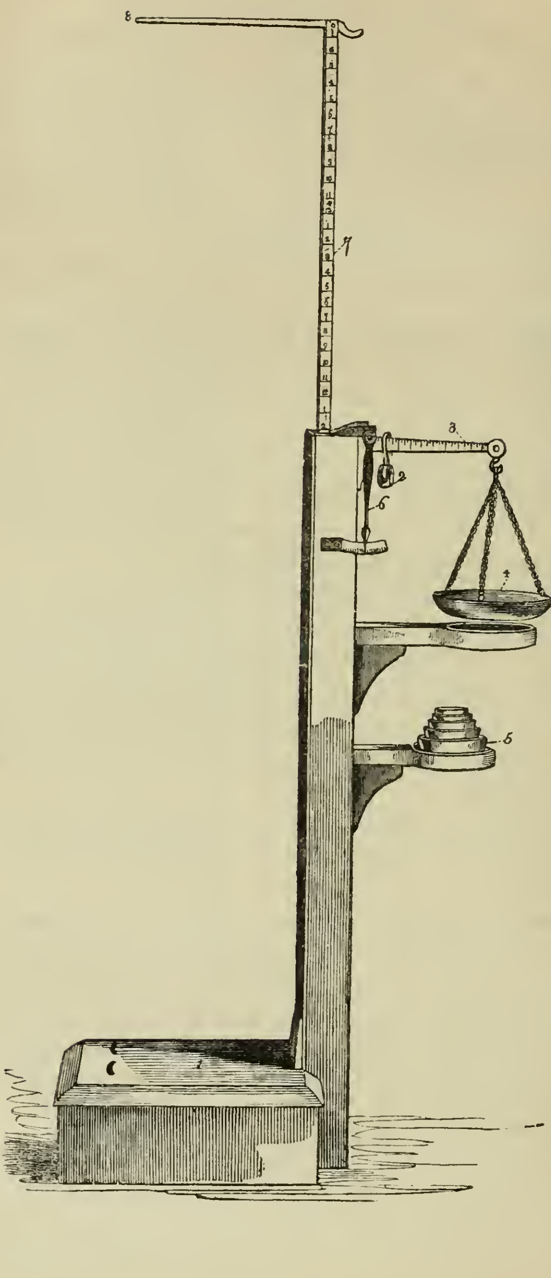
202.—When the Spirometer is not in use, the counterbalance weights had better be taken off, and the tap, fig. 1, left open. The valve will occasionally require a *little* tallow rubbed over that part which is in contact with the socket; *care* must also be taken that the valve is never left out for dust to collect between its sides, which would prevent its being air-tight.

The tap, fig. 4, Diagram 25, is to empty the water out of the Spirometer, which need not be changed more than once a month.

If any water be *drawn* into the air-tube by a person *inspiring instead of expiring*, the tap, fig. 5, will drain this off.

203.—Air-bags are constructed, into which a patient at home may breathe, and which may be sent to any distance, and afterwards adapted to the Spirometer for measurement; in this case the mean of the three expirations only can be taken.

Diagram 28.



Height and Weight.

204.—Diagram 28 represents a view of the instrument for determining the height and weight of the individual to be examined.

This machine occupies less room than a common chair, and so delicately constructed, as to weigh any man to an ounce.

205.—*To take the weight.*—The weights, fig. 5, Diagram 28, are the balance for stones (14 lbs.); the balance-ball, fig. 2, by being moved along the graduated arm, fig. 3, gives the balance for the fraction of the stone in lbs. and quarters.

Let the person to be weighed stand erect upon the part, fig. 1, with his *heels* against the two black marks there represented. Take a sufficient number of weights, fig. 5, as nearly (within 14 lbs.) to balance the man, and put them into the pan, fig. 4, then move the balance-ball, fig. 2, along the arm, fig. 3, until the pointer, fig. 6, stands at zero on the ivory scale; then add together the weights in the pan, to the lbs. marked by the balance-ball on the beam, which will give the weight of the individual.

These small weights multiply 56 times; thus the 16 oz. weight in the pan will balance 56 lbs., or 4 oz. balance 1 stone, or 14 lbs. Each weight has its balance-weight engraved upon it.

The balance-ball always remains on the beam at 0 when not wanted to weigh to the fraction of a lb. When the scales are not in use, it is better to unhook the pan, fig. 4, from off the beam.

206.—*To take the height.*—Let the person remain in the same position; draw out the scale, fig. 7, which is graduated to feet, inches, and eighths, to its greatest length; extend the arm, fig. 8, then slide the whole scale down until the arm, fig. 8, touches the head; and the figure last apparent at the bottom of the scale is the height of the individual.

No allowance is made for the ordinary boots or shoe-heels, nor the weight of the dress. See Note, p. 165 (M. Quetelet).

207.—Let the observation for measuring the "forced ex-

piration" be made *three* times, and the greatest of them be noted as the "Vital Capacity" (31).

208.—The observations made upon the person (28), are as follows :—

Vital capacity, power of inspiration, power of expiration, height, weight, circumference of the chest over the nipples, pulse and respirations per minute (sitting), greatest mobility of the chest, age, and temperature of the room.

The power of inspiration and expiration is determined by another instrument, which is most useful for army-surgeons.

209.—*Order of taking the observations* (208).

1st and 2nd.—Of the pulse and number of respirations per minute.—Place the person to be examined on your right side, reclining at his *ease* on a chair; feel the right pulse in the usual way, with your right hand at the same time resting on his abdomen: in this position you may both count the pulse and number the respirations.

210.—3rd.—*Of the circumference of the chest.*

This is taken by a common tape measure passed round the chest over the region of the nipples, allowing a quarter of an inch for the shirt, and a quarter for the flannel.

211.—4th.—*Of the mobility of the chest* (70).

When the ordinary circumference of the chest has been taken, keeping the tape measure on the same region, request the person forcibly to expire, and note this minimum circumference; then request him to inspire, or fill his chest as much as possible, noting the maximum circumference—the difference between this and the minimum, I designate the mobility of the chest.

This, in healthy persons of ordinary weight and middle age of life, averages three inches—seldom attaining four inches. I have had two cases attaining five, and one six and a quarter inches; these men in consequence measured a vital capacity exceeding 300 cubic inches.

212.—5th.—*Of the height and weight.*—See 206, 205.

213.—6th.—*Of the vital capacity.*—See 198.

214.—7th.—*Of the respiratory power.*

This is measured by an instrument constructed for the purpose (122), a tube from which is to be closely applied to the nostrils by the person making the observation, requesting the party examined to inspire *slowly*, and with his greatest effort. The index of the instrument or column of mercury will point out on the scale the inspiratory power.

215.—The expiratory power is measured in the same way, only with a diametric movement, requesting the person partially to fill his chest with air, and *slowly* to expire with his *greatest* effort.

216.—The mercury should not be jerked upwards or downwards, but slowly acted upon, which will easily be known by its tremulous motion when the greatest muscular power is in operation. This operation is not dangerous; 2000 cases so tested, without any ill effect, warrant me to state this.

217.—It is wonderful to consider that this exertion, when applied by nature, though so considerable (145), is not injurious to the air-cells of the lungs, yet the finest injection, applied with every precaution and skill, will almost universally rupture these delicate cells.

218.—This liability to rupture may probably be accounted for in two ways:—1st. By art, we *over-distend* the lung. 2nd. We apply the power from within. In nature, we neither over-distend the air-cells of the lungs, nor do we apply any force to the inner surface of the air-cell, inspiration being the simple act of the parietes increasing the boundaries of the thoracic cavity.

219.—*To correct for temperature the air breathed into the Spirometer.*—We may estimate the change in the bulk of air as $\frac{1}{500}$ for every degree (F.) of variation of temperature; thus, if a man breathe, in winter, 295 cubic inches of air into the Spirometer, when the thermometer in the room stands at 55°, being 5 degrees below 60°, then $\frac{5}{500}$ must be added to the 295 cubic inches; thus, $\frac{5}{500} = \frac{1}{100} \cdot 295 \times 1 = 295 \div 100 = 2{\cdot}95$ cubic inches, added to $295 = 297{\cdot}95$, or, in round

numbers, 298 cubic inches. On the other hand, if the vital capacity be determined as 215 cubic inches when the thermometer stands at 72°, which is 12 degrees *above* 60°, $\frac{12}{500}$ must be deducted; thus $\frac{12}{500} = \frac{1}{42}$. $215 \times 1 = 215 \div 42 = 5$ cubic inches to be subtracted, making the corrected observation as 210, instead of 215 cubic inches. In a little time the operator can make these corrections without pen or paper. Every one of the observations I have made, has been corrected for temperature.

As it is absolutely necessary that, for comparison, all cubic measurements of air should be as nearly of the same temperature as possible, I purposely constructed the Spirometer to hold a vast quantity of water, because it will be found, during the greater part of the year, our inhabited rooms are generally at the temperature of 60°; thus the water in the Spirometer at these times reduces the observations to 60°, without any other correction. In fact, it is only in the extremes of the seasons, when the water in the Spirometer considerably differs from 60°, that correction for temperature is required. The temperature should always be considered when a suspicious case is examined, to give the individual every advantage.

When all these observations are made (208), and noted in a book properly headed, the state of the person examined is then expressed in the unerring measure of figures—which immediately presents to the eye a certain state of things.

The great epoch in the history of chemistry was the introduction of the atomic theory, the laws of combination and the doctrine of equivalents, founded only upon experimental evidence, and not involving hypothesis.

For a starting point, an arbitrary figure is chosen, from which every combining proportion is relative, and, though the doctrine of atoms and half atoms is beyond our powers of comprehension, yet this arbitrary measure affords a luminous ex-

planation of the laws of the combination of matter. Again, the meteorologist would be quite at a loss to describe the various states of the weather without expressing the same in the definite measure of figures. Just in like manner may the ever-changing qualities of the human functions be expressed. I will here introduce a Table of the comparison of different persons examined, which will at once present to the eye a certain difference of constitution. This difference is no mere theory, but is the expression of a number of facts, which must lead to some sure conclusion :—

Table X.—The Comparison of different Persons in Health and Disease. (Males.)

Initials.	Vital Capacity.	Temperature of the Spirometer.	Power of Inspiration.	Power of Expiration.	Circumference of Chest.	Mobility of Chest.	Respirations per Minute, Sitting.	Pulse per Minute, Sitting.	Height.		Weight.		Age.	Remarks.
									ft.	in.	st.	lb.		
A.	245	60	3·20	5·50	38¼	3½	20	80	5	9	12	9	28	Wrestler.
B.	290	60	3·50	5·30	41	3¼	20	83	6	1	13	8	21	Soldier, H. G.
C.	228	60	3·70	4·20	34	3	18	79	5	6	10	11	23	Thames Police.
D.	464	60	3·15	3·70	50	4	16	78	7	0	21	8	27	Giant.
E.	80	60	3·00	3·74	29	3	29	102	3	9¾	4	7½	35	Dwarf.
F.	108	60	0·75	0·46	35¼	1½	40	60	5	11	10	0	60	Phthisical.
G.	80	60	1·50	2·00	35	1	40	100	5	9	10	0	36	Ditto.
H.	260	60	0·50	1·30	34	3¼	21	64	5	7	10	1	29	Tympanum ruptured.
I.	222	60	0·50	1·00	34½	3	16	80	5	6	10	4	40	Hernia.
J.	186	60	0·70	0·80	36	1½	28	100	5	8	10	3	30	Incip[t] Phthisis

Thus is expressed, as an illustration, the result of this method of observation upon cases I have actually examined.

The eye at once will perceive a great difference in these 10 persons.

The first three are healthy cases; the vital capacity corresponds with the height according to the rule laid down. (Table W., p. 237.)

The inspiratory and expiratory powers are considerable, and bear a proper relation to each other.

The mobility of the chest is also natural, and the weights are indicative of health.

Therefore it may safely be said, these three men have healthy lungs, or, at least, permeable to air throughout their entire extent. Their respiratory power is indicative of great physical strength.

The fourth case (D.) has a remarkable vital capacity; but his height is 7 feet. The respiratory *power* of this man is below par, particularly his expiratory power, indicating that there is some cause existing which prevents his expiratory muscles acting with healthy vigour.

The next case, though only measuring a vital capacity of 80 cubic inches, was of short stature (3 ft. 9¾ in.). This little man's respiratory power was better than the case of D., though his pulse and respirations per minute were certainly objectionable—he is now dead.

F. and G. are examples of persons labouring under phthisis. The stature shows that their vital capacity is *very* much below the natural standard: instead of 108 it should have been 254, and, instead of 80, 238 cubic inches. Their respiratory *powers* are also much too low—the thoracic mobility two-thirds below the standard, and the respirations 40 in the minute.

In casting the eye along the line of figures in the case of H., the striking part is the respiratory power, which is so deficient, while every other observation looks healthy: this was a case of rupture of the membrana tympani. When this man

closed his ears, his respiratory power was manifested as nearly *three* times as strong.

In the case of I., the respiratory power is deficient, from hernia being present.

The last is a case of phthisis in an *early* stage: the measures here are sufficiently marked to excite attention.

The fixed point from whence I judge of the excess or deficiency of a case is from the height; this never varies but in the extremes of age, therefore stature presents a sure guide upon which to ground an opinion. (Compare the vital capacity Table X., p. 245, with Table W., p. 237.)

Before I conclude, I may venture to draw the attention of those connected with insurance offices to the matter of this paper. Thus, the state of a man examined, and appearing like the three first cases in Table X., would admit of little doubt but that such was an assurable life, while the other cases would be suspicious. From such a table of facts, any man can form his own judgment of a case, without being dependent on the opinion of another. Therefore, to insurance offices, as well as to the medical profession, the Spirometer, I think, would be found useful.

EPITOME.

Nothing rightly was known upon the functions of the respiratory organs previous to the discovery of the circulation of the blood, the pressure and composition of the atmosphere (1, 2).

Of the mechanical division of respiration (3).

To comprehend the function of respiration, the breathing act must be divided into different heads (4, 5, *et seq.*), which is here illustrated by a Diagram, (10,) and their characteristic differences described (12).

The subject of this paper resolves itself under seven heads (15).

First.—*Of the quantity of air expelled from the lungs in connection with other physical observations on the human frame* (16).

The observations hitherto made upon the subject appear discrepant (17 *et seq.*) for obvious reasons (22-26), and how such can be avoided, not only in considering respiration, but any other physiological or pathological research (27).

Many other points besides the one here sought for have been observed (28), in the various classes examined (30).

Of the vital capacity.—This differs in man according to height, weight, age, and disease (35).

By *height*, in the arithmetical relation of 8 cubic inches for every inch of height between 5 and 6 feet (36-41).

By *weight*, at 5 feet 6 inches it decreases 1 cubic inch per lb. between $11\frac{1}{2}$ and 14 stone (53-56). At other heights 7 per cent. must be added (60) to the weight given in Table G., p. 166. The weight increases in a certain relation with the height in 3000 cases examined (58 *et seq.*, Table F., p. 165). The weight may be calculated from the height (59).

Table of the effect of weight on respiration (pp. 162 and 163), shown also by a Diagram (p. 164).

By *age* (61).—Age, after a certain time, decreases the vital capacity, as shown by Tables I. and J., (p. 170 *et seq.*), and by a Diagram (p. 172). The decrease is nearly $1\frac{1}{2}$ inch per year between 30 and 60 years of age (64).

By *disease*, the vital capacity decreases from 10 to 70 per cent. (163 *et seq.*; Table, p. 156; Diagram, p. 224; Table, p. 218; also the 7th head, Practical Remarks, p. 216).

Second.—*Of the absolute capacity of the thorax, and its various dimensions* (73; see Table, p. 176).

The size of the chest, and the quantity of air a man can breathe, have no direct relation with each other (73 *et seq.*).

The circumference of the chest, also, has no relation to the vital capacity (Table K., p. 173); but it has an exact relation

to the weight, increasing 1 inch for every 10 lbs. (71; Table D., p. 162; dotted line in Diagram 3, p. 164).

A stout man may have large lungs, and a spare man may have small lungs; there appears no relation between the cubic space in the thorax and the weight. See Table L., p. 176, and then compare the 5th column with the 18th.

The size of the chest, and its mobility, bear a strict relation to the quantity of air we breathe; a 40-inch chest, with 3 inches mobility, will breathe less in a deep expiration than a 40-inch chest with 4 inches mobility (70, 92, 107, 117, 178).

The cubic mobility may exceed the cubic cavity of the chest (79).

There is no relation between the height and the cubic dimensions of the thorax (Table L., p. 176; compare the 4th column with the 18th).

There appears no relation between the sitting and standing height (90).

Third.—*Of the respiratory movements, &c.* (90.)

The ordinary breathing in the two sexes differs (113). In men it is chiefly by the diaphragm (97, 98, 112); in women chiefly by the ribs (113).

Extraordinary breathing is the same in the two sexes (dotted line, Diagrams 13 and 19;)—(100, 113).

When we examine the breathing movements, the position of the body must be considered (116).

The chest in inspiration does not increase its dimensions equally on all sides (Diagram 14, fig. E;)—(104 *et seq.*; 140).

It is questionable whether the diaphragm descends in the act of *deep* inspiration (102-104).

The breathing movements in the male shown by Diagrams 13, 16, 17, 18; female, 19, 20.

In deep expiration the body shortens (110, 115).

Fourth. — *Voluntary inspiratory and expiratory power* (119, 121, 144).

The expiratory power is manifested greater than the inspiratory; (122-126; 146; Table M., p. 201).

A certain relation exists between the height and the inspiratory power (124; Diagram, p. 202).

The power of the respiratory muscles is very considerable (143 *et seq.*); case of the greatest power nearly equal to 2 tons (147).

In testing the respiratory power by suction, the hydrostatic law of the pressure of fluids must be considered (144; note, p. 198).

Fifth.—*Of the elasticity of the ribs and voluntary respiratory power* (127).

Great difference manifested between the inspiratory and expiratory power, chiefly due to the elasticity of the ribs (131 *et seq.*); their power measured (134); their power in the different inspiratory stages calculated (138 *et seq.*).

The voluntary and elastic power is combined in expiration, but antagonise each other in inspiration (146).

Sixth.—*The effect of decussating diametric and oblique power in reference to the function of the intercostal muscles* (148).

The external intercostal muscles are inspiratory, and each muscular lamella takes its fixed point from the rib next above, to elevate the rib below (152).

The ribs decussate in inspiration, and converge in expiration (155).

Seventh.—*Practical deductions* (p. 216).

Cases given, illustrating the use of the Spirometer as a means of detecting disease (156 to 175). Table of observations in phthisis pulmonalis (p. 218).

The vital capacity and the respiratory power of the healthy

and diseased compared (Diagrams 23 and 24, p. 224). Table of the vital capacity in health, for reference (p. 237).

The natural number of respirations and pulsations per minute (187 *et seq.*).

They may be affected by sudden changes in the atmospheric pressure. The result of an experiment is given in descending a coal-mine, where the respirations are quickened (191 *et seq.*). The effect of atmospheric pressure appears less regular upon the heart's action. Diminished atmospheric pressure is probably too little, from meteorological causes, to be observed by the pulse (p. 230).

How to hold the breath nearly three times longer than natural (193).

Directions for using the instrument in measuring the vital capacity, &c. (p. 235). Arranging the Spirometer, with a sketch of this instrument (p. 235).

The attitude of the body described by a sketch, when about to measure the vital capacity (p. 236), with a Table of reference (p. 237).

A convenient method of determining the height and weight, with a sketch of the scales, &c. (p. 241).

The order of taking the collateral observation (209 *et seq.*), and rule for making the corrections for temperature on the respired air, the vital capacity here being invariably expressed as at 60° (F.) (219).

Method here recommended of expressing the different conditions of the human frame by figures (p. 244 *et seq.*), with an illustration given in a tabular form (Table X., p. 245), and remarks upon these cases.

The matter of this communication is founded upon a vast number of facts—immutable truths, which are infinitely beyond my comprehension. The deductions, however, which I have ventured to draw therefrom, I wish to advance with

modesty, because time, with its mutations, may so unfold science as to crush these deductions, and demonstrate them as unsound.

Nevertheless, the facts themselves can never alter, nor deviate in their bearing upon respiration—one of the most important functions in the animal economy.

HYDATID CYST,

EITHER ORIGINATING IN, OR PRESSING UPON, THE PROSTATE GLAND.

By GEORGE LOWDELL,

LATE HOUSE-SURGEON TO THE SUSSEX COUNTY HOSPITAL.

Communicated by JAMES PAGET, F.R.C.S.

Received March 17th—Read May 26th, 1846.

John Ireland, ætat. 64, admitted into the Sussex County Hospital, July 1844, under the care of Mr. John Lawrence, jun. The account given by him on his admission is, that he gains his living by shrimping, and is, consequently, exposed to continual wet; he has been imperfectly clothed, and badly fed. He has experienced some difficulty in passing water for three or four years, and has frequent micturition, but thinks he has never, during the whole of that time, completely emptied his bladder. This difficulty has lately amounted to almost complete retention, and for some days he has only passed urine by drops.

The bladder, when he was admitted, was extremely full, and he was suffering severe pain. Attempts had been several times made to pass a catheter, before he came to the hospital, but without success. The same result attended the first trial after he was admitted. The instrument passed with great facility to the prostatic portion of the urethra; and thence its point diverged into numerous false passages. At one time, though the instrument was apparently in its right direction, its point was felt above the pubis, anterior to the

bladder: at another time it was lost in some deeper position, and when examined for by the rectum, a large, obscurely elastic tumour, in the situation of the prostate gland, was discovered pressing on the gut, and nearly filling the pelvis. The man's state of debility, with a dry tongue and a low small pulse, forbade any long-continued attempt to pass the instrument, and he was accordingly ordered a warm bath, which very much relieved his pain, and enabled him to pass a small quantity of urine. Still his bladder continued very much distended: after a few hours, therefore, a second attempt was made to pass the catheter, and, after a few trials, a small one (No. 4) luckily passed into the bladder. Three pints of highly alkaline urine were drawn off; but there was no diminution in the size of the tumour felt by the rectum.

The bladder being emptied of its contents, a more careful examination of the abdomen was made, and two small tumours were felt, in the direction of the arch of the colon. These were at the time supposed to be scybala, but, though glysters brought away a large quantity of hard feculent matter, these tumours continued in the same state. The catheter was retained in the bladder, and a quantity of ropy mucus and semi-purulent matter passed away; and, though by this means he was saved the pain and uneasiness arising from a distended bladder, yet his general symptoms were in no way relieved. He sank into a state of hopeless exhaustion, and died a few days after his admission.

Post-mortem examination twenty-two hours after death.—The peritoneum, in the neighbourhood of the bladder, was dark, black, and softened. The cellular tissue about its neck, and that covering the psoas and iliacus muscles, was boggy and soft; the muscles themselves being discoloured and flabby. The bladder was very much thickened, and in the situation of the prostate gland was a tumour larger than a fetal head, which, when cut open, proved to be an hydatid cyst, so full of hydatids compressed together, that the cut

surface presented a wavy appearance; the true substance of the prostate being lost in this thickened cyst. The course of the urethra was healthy throughout; but this prostatic portion had been so pressed upon by the tumour, that, in attempting to pass the catheter, numerous false passages had been made in every direction. Between the layers of the omentum, and in close proximity to the arch of the colon, were two tumours, also containing hydatids within a thickened and hardened cyst.

The other viscera were healthy.

On a minute examination of the diseased parts, it was found that, excepting a small portion in front of the false passage, through which the catheter was passed, the whole of the substance of the prostate was lost; but whether the hydatid cyst were formed in the prostate itself, or whether the cyst originating externally to the gland, and being bound down by the deep pelvis fascia, had, with its growth, so pressed upon the gland as to cause its total absorption, is a matter of doubt. I was at first inclined to the former opinion, but, as I cannot find any similar case recorded, as there were other hydatid cysts found in the omentum, and as the position was such that the cyst by the prostate might have had its origin external to the gland, I should be scarcely warranted in maintaining that opinion without question: still, be it the one or the other, the case altogether is one of so unusual occurrence, that it cannot fail to excite interest.

APPENDIX.

*A Case of Retention of Urine occasioned by a Cyst containing Hydatids developed in the Pelvis; communicated by T. B. Curling.**

Michael Driscoll, ætat. 58, a labourer, was admitted into the London Hospital, under the care of Mr. John Scott, 7th Sept. 1840, in the evening, with complete retention of urine, which had existed since the middle of the previous night. He was in great suffering, the pain being wholly referred to the perineum. He stated that, for some time before, he had only been able to pass water with much difficulty, but it had never entirely stopped until that day. Examination by the rectum indicated enlargement of the prostate. A large catheter was introduced without difficulty, and two pints of urine were withdrawn. Although the evacuation of the fluid afforded much relief, he still complained of great pain in the perineum, to which leeches were applied, after he had been in a warm bath and had taken castor oil.

8th.—Pain and tenderness *in perineo* were much increased. The abdomen was tense, tympanitic, and very tender on pressure. Some calomel and Dover's powder was ordered to be given every six hours. The catheter was twice passed in the day without difficulty.

9th.—The pain and tenderness were still great, both in the perineum and in the abdomen. An ineffectual attempt was made in the early part of the day to pass a catheter; but, in the evening, no difficulty was experienced, and a large quantity of urine was withdrawn, but without affording any relief.

10th.—The catheter was twice introduced without difficulty, but there was no improvement in the general symptoms.

11th.—The pain was considerable. A catheter was passed

* I am indebted to Mr. Page, Surgeon of the Carlisle Infirmary, for the history of this case. The account of the morbid appearances is taken from the Hospital Post-Mortem book.—T. B. C.

in the morning, but only three ounces of urine were withdrawn. In the evening 60 ounces were drawn off. The patient was very low and weak. He was ordered to take wine, ammonia, &c. During the whole of the following week the catheter was passed two or three times each day with but little difficulty; sometimes no urine, at others only a small quantity, and occasionally a very large quantity, was passed by it. The water dribbled away from him unconsciously at times.

18th.—The man was apparently sinking, and had diarrhœa in addition to his other ailments. An increased quantity of urine passed involuntarily. He was ordered opium, chalk, &c.

20th.—A catheter was introduced, but no urine followed, although it still dribbled away in the bed. The diarrhœa continued, and debility was increasing. Ordered brandy, &c., *ad lib.*

22nd.—He was a little revived. Urine continued to flow involuntarily. He complained much of pain in the abdomen, which was excessively distended. A careful examination by the rectum was made, and a tumour was felt in the situation of the bladder, conveying to the finger an indistinct sense of fluctuation. It being supposed that the bladder might be filled with coagulated blood, a large prostate catheter was introduced with difficulty, and about six ounces of warm water was injected, a part of which gushed out on the withdrawal of the catheter, the remainder being retained, although an attempt was made to withdraw it by means of a syringe. Opiate injections were frequently repeated.

23rd.—He was weaker. The tympanitic state of abdomen and tenderness were much increased. About a pint and a half of urine passed involuntarily in 24 hours.

24th.—The pain was excessive. The quantity of urine which passed involuntarily was diminished. From this time he gradually sunk, and died on the morning of the 28th.

The body was examined 20 hours after death. The abdomen was enormously distended. On dissecting back the integuments, a small ventral hernia, containing omentum, was found between the umbilicus and sternum. The intestines, particularly the transverse arch of the colon, were distended

with gas; the peritoneal covering was injected, especially in the hypogastric region, where much lymph was effused, producing adhesions of the convolutions of the intestines. The bladder was empty and contracted, and pushed far forwards to the pubis. Between the bladder and rectum there was a cyst, which burst in the removal of the parts from the body, and gave exit to more than a pint of clear fluid. This was found to be an hydatid cyst, the size of an ostrich's egg. It pressed on the bladder in front and rectum behind, and quite filled the pelvis. On laying open the rectum, it was seen to be considerably contracted for about two inches of its extent. The coats were much thickened, and contained between them an hydatid cyst, the size of a large walnut, and unconnected with the larger cyst. The inner surface of the bladder was very rugous, and the mucous membrane of a deep red colour. The urethra was very much displaced upwards. It was lacerated about an inch from its vesical extremity, and there was a long sinus extending for a considerable distance, partly through the coats of the bladder, and partly between the bladder and the larger hydatid cyst, and communicating with the abdomen through an opening in the peritoneum. There was extensive purulent infiltration of the cellular membrane of the pelvis passing upwards in the course of the iliac vessels to the aorta. The iliac and lumbar glands were in a state of commencing suppuration. A third hydatid cyst was found connected with the right lobe of the liver. It extended upwards to the diaphragm, and downwards to right kidney and pancreas. On this cyst being opened, there escaped about three pints of a deep yellow fluid and two large hydatids; one of which, of the size of an orange, was removed whole; the other, which was apparently much larger, broke in the removal. A fourth hydatid cyst, of smaller size, was attached to the pancreas and duodenum. The heart was large, and its valves slightly ossified. The lungs were healthy. The kidneys were soft and vascular.

The false passage appears to have been made on the 22nd, when the attempt was made to inject the bladder.

CASES

OF

VARICOCELE

TREATED BY PRESSURE,

WITH OBSERVATIONS.

By T. B. CURLING,

LECTURER ON SURGERY, AND ASSISTANT-SURGEON, AT THE LONDON HOSPITAL.

Received April 1st—Read June 9th, 1846.

Three years ago, a case of varicocele, cured by the application of pressure to the spermatic veins, came under my notice, and being struck with the peculiar adaptation of this plan of treatment, to counteract the injurious effects of the dilated veins, I determined to give it a trial. In a work on the Diseases of the Testis, which appeared a few weeks afterwards, I stated the object of this method of treatment to be, —"the maintenance, whilst the patient is in the upright position, of such a degree of pressure on the spermatic veins as may be sufficient to relieve them from the superincumbent weight of the blood, without at the same time endangering the integrity of the testis, by obstructing the spermatic artery, and without causing so much uneasiness as to render the remedy as painful as, or more difficult to be borne than, the disease. This pressure must be continued a sufficient time, to enable the coats of the vessels to return to their natural dimensions, and to acquire strength to carry on the

circulation. When this is effected, the patient is cured."* I also remarked, that "I look forward with no slight interest to the result of further trials of a remedy, which seems to me to be based on sound views of the pathology of the disease," and that this "plan appears to be particularly applicable to cases of varicocele in young persons, whose reparative powers would be sufficient to restore the veins, when relieved of pressure, to a healthy state."† Since these observations were written, I have treated many cases of varicocele by pressure; and as a sufficient period has now elapsed, to enable me to form a just opinion of the value of this plan of treatment, and of its advantages over other methods, I venture to submit the results of my experience in the management of this complaint, to the consideration of the Fellows of this Society. The following are cases in which firm, steady, and continued pressure on the spermatic veins at the external abdominal ring succeeded in curing the disease.

Case 1.—*Varicocele cured by pressure at the end of* 19 *months.* —J. H., a tall spare man aged 22, a cabinet-maker, applied to me at the London Hospital in May 1843, on account of a varicocele on the left side; there was a considerable bunch of dilated veins above and behind the testis, which was about one-third less in size than the right testis. He had noticed the complaint between two and three years, and it was increasing in size; for the last two years he had worn a suspender, but latterly it had not afforded him the relief he at first experienced from it. He suffered a dull aching pain in the course of the spermatic cord, and this became worse towards evening, and after standing or much exertion. The moc-main lever truss was applied on the 8th.

May 11.—The patient complained of uneasiness from the pressure of the truss, but stated that it was not greater than he could easily manage to bear. He was relieved from the aching pain, and there was a decided diminution in the size of the dilated veins, though he had discontinued the use of a

* P. 170. † P. 475.

suspender; but this he was directed to resume. The truss was ordered to be worn day and night.

June 7th.—He had worn the truss constantly, and suffered very little from it. There was scarcely any appearance of dilated veins, and no uneasiness in the course of the cord.

December 20th.—On a careful examination of the parts in the after part of the day, the truss being on, no enlargement of the veins could be distinguished. He had become accustomed to the truss, which he wore without inconvenience, taking it off at night.

December 19th, 1844.—On examination of the parts after removal of the truss, there was no appearance of varicocele, and the left testis had acquired the same size as the right. I considered the complaint cured, and allowed the patient to discontinue wearing the truss, but cautioned him to avoid those circumstances which would tend to reproduce the disease.

Case 2.—Slight varicocele cured by pressure at the end of 7 *months.*—A young man, aged 24, a medical assistant, in rather impaired health, applied to me in July 1843, on account of a varicocele on the left side. It came after an injury, accompanied with strain, which occurred to him in the February preceding. The spermatic veins were not enlarged to any great extent, but they were distinctly varicose, and he experienced considerable uneasiness in the cord, especially after standing for some hours in his business. He had worn a suspender, which gave him only partial relief. The left testis was rather smaller than the right. His countenance had an anxious expression, and he was uneasy in his mind about his case. His bowels were costive. I prescribed an aperient pill, and some tonic medicine, and directed the truss to be applied; and, as usual, recommended him to avoid fatigue and straining efforts. I saw nothing more of this patient till nearly a month after his first visit, when he called, and said that he was much relieved, and to a greater extent than he could have expected in so short a period. On examining him with the truss on, I found the spermatic veins less di-

lated than when I first saw him. He said the truss fretted his skin a good deal at first, but this had been remedied by interposing some wash-leather between the pad and skin. He was able to continue in his business, standing or moving about nearly all day. His countenance had lost the anxious expression, and his general health was improved. This patient visited me again February 3, 1844. He had been in the country, and had returned in improved health. He felt quite well, but still wore the truss. I could detect no enlargement of the spermatic veins, and considered the varicocele cured, though, as a precaution, I recommended him to continue wearing the truss for a few months longer.

Case 3.—*Double varicocele cured by pressure in* 10 *months.* —A gentleman, aged 24, of spare form, pale countenance, and subject to indigestion since infancy, consulted me in May 1844, on account of a double varicocele. There was evident enlargement of the spermatic veins on the left side, and a very slight dilatation of these veins on the right. He had been troubled with the complaint about a twelvemonth. He had worn a suspender for many months, but the swelling and inconvenience were increasing. I noticed a dilated condition of the superficial veins throughout the body, the veins of the penis, thighs and legs being especially large and prominent. He was of a costive habit. On the 22nd instant I directed a double truss to be applied. I also recommended the legs to be bandaged with stocking-web rollers, a cold bath to be taken daily, the bowels to be kept open by an injection of cold water, in the morning, and prescribed the citrate of quinine and iron.

July 23rd.—He had steadily worn the truss since I last saw him, during which period he had been travelling in Germany and Switzerland. His health and digestion were improved. The spermatic veins on the left side were diminished, and all uneasiness was removed. No enlargement of the veins were observed on the right side.

March 6th, 1845.—There was no appearance of varicocele, nor uneasiness on either side. I considered the complaint

cured, but recommended the patient to continue the use of the truss for six months longer.

To these examples of cure by pressure, I could add two other cases, if necessary, to establish the value and utility of this plan of treatment, besides the case mentioned in my work on the Diseases of the Testis,* and another case also alluded to, of a gentleman aged 27, who was affected with a rapidly increasing varicocele, for which he had worn a truss two months with benefit, when he quitted this country for Canada. He returned to England at the expiration of three years, and was seen by my friend, Mr. Daldy, of New Broad-street, who found the varicocele quite cured. This patient had left off the truss after wearing it fifteen months.

In the above cases the dilatation of the veins had taken place at a comparatively early period of life, was not excessive, nor in two of them of long duration, but was productive of more or less inconvenience and uneasiness, which could be only partially, or scarcely at all, remedied by the suspender; they were precisely the cases in which it was presumed that pressure, by relieving the veins of the superincumbent weight of the blood, would enable their coats to recover their proper size and tone.

The same method of treatment has been applied to several other cases of varicocele, of a like character to the above, in some of which, after the patients had derived so much benefit from it, that hope was entertained of a permanent cure being effected, they ceased to remain under my observation; and in others, though the treatment had been hitherto satisfactory, the painful symptoms having been entirely relieved, a sufficient period had not elapsed to enable me to judge of the ultimate result. In two of these cases, the relief afforded by the truss to the distressing symptoms occasionally attendant on the disease, was so immediate and so great, that I am led to give them in detail.

Case 4.—Painful varicocele relieved by pressure.—In March 1845, I saw, in consultation with Mr. Ebenezer Smith,

* P. 171.

of Billiter-square, a gentleman aged 25, who was affected with a distressing varicocele on the left side. He was single, and of delicate appearance, but his general health was represented to be pretty good. He had been troubled with the complaint for about four years; but notwithstanding the use of a suspender, the uneasiness had continued to increase, and at length had become so severe, that he was unable to attend to business, or even to walk a short distance without lying down afterwards. On his entering my room, he begged to be allowed to place himself on the sofa, in order to procure relief, and he afterwards remained in the recumbent position for half an hour before leaving the house. On examination, I found the dilatation of the spermatic veins on the left side by no means considerable. The testis was of proper size, but the seat of a good deal of morbid sensibility. On making tolerably firm pressure on the spermatic veins at the external abdominal ring with the fingers, and continuing it whilst the patient walked backwards and forwards in the room, no uneasiness whatever was experienced, whereas the pain returned in a few minutes after the pressure was remitted. The application of the lever truss was consequently recommended. This patient called on me again at the end of two months, and stated that he had derived great relief from constantly wearing the truss, and was able to take exercise and to attend to business, though he still suffered from the complaint at times, especially after fatigue.

Case 5.—*Varicocele relieved by pressure.*—Charles Bye, a short, thick-set man, aged 24, applied to me in January 1846, for my advice respecting a varicocele on the left side. There was a good-sized plexus of dilated veins, which caused a sort of dull aching pain, that rendered him low-spirited, and prevented him from continuing in his business as a messenger and weigher in the Custom House, his sufferings being increased by the least exertion. He had been troubled with this complaint for nearly five months. He had been a jockey in the service of Lord G. Bentinck since he was a boy, but had recently given up this occupation in con-

sequence of being overweight. He attributed the varicocele to a hurt from a fall in riding. He had been under the treatment of different surgeons for three months, but had obtained no relief. I ordered the lever truss to be applied.

February 10th.—He called and stated that he had obtained the truss, from which he had derived such immediate relief, that he had returned to his occupation next day, and had been able to follow it ever since,—a period of three weeks.

March 27th.—He continued free from all uneasiness in the cord, and the dilated vessels were reduced in size.

Patients afflicted with varicocele in early life, often labour under a degree of mental distress very much out of proportion to the actual disease. These hypochondriacal symptoms are partly owing to the dyspepsia so commonly coexisting with this complaint, and partly to an apprehension, by no means unfounded, of the disease impairing the nutrition of one of those organs which exercise a marked influence on the characters of the sex. By appropriate general treatment and encouraging advice, combined with local treatment, the painful feelings alluded to may generally be removed. In other instances, the uneasiness in the testis and spermatic cord, and even in the loins, is so great as to produce much real suffering, and to prevent the person affected from making any kind of exertion. In Case 4, which was an instance of this kind, the patient was prepared to submit to an operation, had I recommended one, but the benefit derived from the truss was sufficient to render so severe an alternative unnecessary. In this case, the distention of the veins was so slight, that I think the relief obtained may be in some measure due to the pressure made on the spermatic nerves.

Little attention, I believe, is paid to constitutional treatment in varicocele, which is commonly regarded as exclusively a local disease. In the class of cases in which the benefit derived from pressure is most apparent, the subjects of the disease are persons between 18 and 30 years of age, of weak frame and constitution, and subject to dyspepsia, and

whose venous system and circulation are feeble, as is evinced by the large size of the superficial veins, particularly in the lower extremities, paleness of the countenance, and cold hands and feet. In these cases, the operation of local remedies may be aided materially by general treatment, such as the exhibition of steel and quinine, a nutritious diet, sea-bathing, and similar measures, calculated to improve the tone of the system.

In estimating the value of the treatment by pressure,* in effecting a cure of varicocele, it must not be overlooked, that although the veins may have recovered their proper size and tone, a return of the complaint would in most cases be readily induced by the causes ordinarily producing distention of the spermatic veins, and that unless the patient avoided these causes, such as constipated bowels, straining efforts, and prolonged fatigue, he may be disappointed in deriving permanent benefit from the treatment. For this reason, the continued use of the truss, after all symptoms of the affection are removed, may often be advisable as a matter of security, more especially in persons who are obliged to lead an active life, or who have naturally a feeble constitution or impaired health.

There are very few cases of varicocele occurring in early life in which the common suspender is sufficient to prevent the increase of the complaint and the suffering attending it. In the cases which I have related, the painful symptoms of the disease could not be remedied by this mode of supporting the parts, and the patients were consequently anxious for further assistance. There is, however, another class of cases in which the application of pressure is capable of giving considerable relief, though not of curing the disease. They are cases met with at a somewhat advanced period of life, in which the varicocele is considerably developed, the plexus of dilated veins, though of gradual formation, being of large

* Several patients affected with varicocele have mentioned to me, that they had been in the habit, whilst walking about, of pressing on the groin with the fingers, having found out that considerable relief could be obtained by this means.

size and long standing, but not productive of greater inconvenience than a sense of weight and aching after fatigue, and when the part is deprived of support. The uneasiness in these cases may generally be remedied by the use of a suspender, but this seldom succeeds in preventing the progressive increase of the varicocele, which occasions a gradual wasting of the testis, and sometimes assumes a painful character. The application of pressure, however, not only removes the slight uneasiness which exists when the veins are pendent, but also counteracts the tendency to further dilatation, though the enlargement is too great to admit of the vessels being reduced to their former size. I could, if necessary, adduce several cases in which pressure was resorted to, with a beneficial effect, in checking the growth of large varicoceles.

From these observations it will appear that I consider the treatment by pressure, to be applicable either for the cure or relief of the majority of cases of varicocele occurring in practice. Certainly in all those cases in which tolerably firm pressure, with the fingers, at the abdominal ring, removes the sense of weight and uneasiness along the cord, this plan may be tried with every prospect of a beneficial result; and its simplicity, freedom from all risk, and efficiency, in my opinion, render it superior to every other mode of treatment that has hitherto been resorted to.

In all the cases of varicocele which I have treated by pressure, I have employed the moc-main lever truss, which seems better adapted to make the necessary pressure on the spermatic veins at the external abdominal ring than any other instrument that I know of. It is not liable to shift, and, what is very important, the degree of pressure can easily be regulated by the patient. I have used it with success in cases where the patient has tried other trusses without obtaining relief. The truss should be applied so as to make rather firm pressure: it often happens that, though worn with comfort after being adjusted in the morning, towards the after part of the day it begins to produce uneasiness. When this is the

case, the pressure may be diminished. In general, the truss need be worn only during the day, though in some instances I have thought it advisable to recommend its use during the night also. Thus in one case the patient suffered uneasiness in lying on the side affected, and was able to pass a better night on wearing the truss. When the scrotum is unusually pendulous, or when the veins are very long, and form a plexus of any size, I advise the addition of the silk net suspender, which may be readily adjusted to the truss.

ACCOUNT OF A CASE

OF

CONGENITAL DEFICIENCY OF ONE KIDNEY,

WITH

GRANULAR DEGENERATION OF THE EXISTING ONE.

By GEORGE BUSK,

SURGEON TO THE SEAMAN'S HOSPITAL SHIP "DREADNOUGHT."

Received June 18th—Read June 23rd, 1846.

Not having seen the subject of the present case during life, I am indebted for the principal part of the following account of his illness to the gentlemen under whose care he had been, Mr. Ceeley, of Aylesbury, and Mr. Burton, of Greenwich, who had charge of him for the last ten days; and the latter gentleman having requested me to assist him in the inspection of the body, I am induced, by the singularity of the appearances, to lay an account of them before the Society.

The patient was a gentleman of literary occupations, but accustomed to much exercise, and, apparently, in the enjoyment of good health, until within the last three years of his life. His habits had always been extremely regular and temperate. He had resided many years at Cambridge, and latterly at the village of Stone, in Buckinghamshire, whence he came to Lewisham a short time before his decease. About three years before his death, which occurred at the age of 27, his friends observed an alteration in his appearance; he became bloated and pale, and incapable of as much exertion as formerly; he was, however, able to continue his usual pursuits, and even to go out with the hounds up to Christmas last; and himself made no complaint of illness till about the

beginning of March, when he consulted Mr. Ceeley; but he had previously, on the advice of a friend, taken a considerable quantity of calomel, which had induced salivation of no long continuance. At that time the bowels were occasionally irritable, with an inordinate secretion of bile, and sometimes torpid, with a deficiency in that secretion. His appetite was lost, and he complained much of languor and lassitude; his legs also became anasarcous. He suffered from occasional attacks of painful swelling of the foot, which were of short duration, and considered to be of a gouty nature. The stomach became more and more irritable, and he frequently vomited. He was troubled with epistaxis to a great extent, and, it appears, had been subject to nasal hæmorrhage from childhood. In May, on the occasion of an attack of the gouty affection, the urine is noted to have been acid and albuminous, with a specific gravity of 10·10. He passed about three pints in the 24 hours. The superficial veins on the surface of the chest were at this time (May 5th) observed to be considerably enlarged. The heart's sounds are stated to have been normal, but there was dulness, on percussion, over a considerable space in the præcordial region, and the impulse of the heart is described as inordinate; the pulse 104. Mr. Ceeley noticed, on the subsidence of the ptyalism, a small crack-like sore on the frænum linguæ, which appears never to have healed; from the 3rd to the 6th of May there was constant oozing of blood from the mouth. On the 10th of May, to the other symptoms was superadded a painful attack of hæmorrhoids. The tongue was, towards the end of life, extremely sore, and cracked longitudinally; the urine pale, and reduced in quantity to one pint and a half in 24 hours, and highly albuminous. The hæmorrhage from the mouth and nose frequently recurred, and latterly was copious, and almost continuous. The strength became much reduced, especially in the lower extremities, where the weakness amounted to a degree of paralysis. A few days before death, the under side of the tongue and the inner surface of the cheeks became gangrenous, and the mouth afforded a copious

viscid, mucoid and extremely offensive secretion. The body exhaled a strong and peculiar, and somewhat urinous, odour. Death took place on the 16th of May.

The body was inspected by Mr. Burton and myself 24 hours after death. It retained the strong urinous (?) odour, and was extremely rigid, presenting no external signs of decomposition. The chest was remarkably narrow, and the muscular development generally spare; but, in other respects, nutrition appeared to have been good. There were two congenital deformities, the left hand presenting a supernumerary thumb of nearly equal size with the proper one; and, on the right foot, the distal phalanx of the fourth toe was wanting. The gums of the lower teeth and the inside of the lower lip were green, and apparently gangrenous, and fetid greenish pus oozed from between the lips. The gums of the upper teeth were natural.

The *head* was not examined.

Thorax.—The right lung was free and of normal appearance, though slightly congested posteriorly. The pleural cavity contained about six ounces of clear straw-coloured serum, but presented no signs of inflammation. The left lung was universally adherent by old, tough, membranous bands, but was otherwise natural, though slightly compressed by the enlarged heart. The *pericardium* occupied a considerable space, and contained about four ounces of clear, pale, straw-coloured fluid.* The heart was about double the natural volume, and loaded with fat externally. The cavities were all equally enlarged, and the walls of the left ventricle, notwithstanding their uncontracted state, were, on an average, fully three-quarters of an inch in thickness, the muscular columns being proportionately developed. All the valves were in healthy condition, nor was any morbid change in the

* In which abundance of urea was detected.

endocardium perceptible. The muscular substance of the heart was pale, but firm. Very small and very soft black coagula occupied the cavities of the heart and large vessels adjacent.

Abdomen.—The omentum and mesentery were loaded with fat. The *stomach* contained a tenacious fetid fluid; the mucous membrane was injected and of a dark colour, but natural consistence: that of the duodenum and of those parts of the small intestine which were examined, was also of a purple colour from vascular injection, and the solitary follicles in the duodenum were numerously developed and very large. The appendices epiploicæ were large and numerous, and the colon was contracted, containing only a few small scybala. The *liver* was about one-third larger than natural; it appeared to elevate the diaphragm considerably, and at the same time its anterior edge, which was remarkably rounded, descended considerably below the cartilages of the ribs. Its surface was smooth; the colour pale brown, with rather darker dots, and the texture close. It did not grease the scalpel, but, under the microscope, it presented a large quantity of oil. The gall-bladder contained a small quantity of pale bile. The *spleen* was soft and pulpy, of natural size, and exhibited, immediately beneath the external capsule, three or four collections of a thick white fluid, resembling pus. These collections were about the size of a large pin's head, and none were found in the interior of the gland, even upon numerous sections being made. *Kidneys.*—No trace whatever of the left kidney or supra-renal capsule could be found on the most careful search. The right kidney was about 2 inches in length, by $1\frac{1}{4}$ in width, and presented externally a contracted or corrugated aspect, and the roughened capsule could not be stripped off to any extent without laceration of the substance of the gland. The colour of the kidney was very pale, speckled with white, and on a section, scarcely any distinction of substances was observable. The whole presented a condensed, cicatriform aspect, of a semi-transparent hue, sprinkled with small opaque specks, and, in the remains

of the tubular portions, marked with white striæ, obviously vessels filled with a dense white material. The pelvis was remarkably small, and the mammillary processes appeared also to be unusually few in number. The ureter connected with this kidney was of the natural size. The *bladder* was of usual size and form when inflated. The left ureter entered the bladder at the usual situation, and was traced upwards in the natural course for about six inches, where it ended in a cæcal point. The tube was about the size of the vas deferens, but not so thick to the feel; its canal was very narrow, but pervious into the bladder. The vasa deferentia, vesiculæ seminales, prostate gland and testes, were all of natural form and size.

The substance of the kidney was examined microscopically: the tubuli uriniferi were found to be in parts indistinct, or obliterated, and in others to be filled with a semi-opaque white granular material, soluble, or rendered transparent by acetic acid, and presenting none of the characters of oil, very few globules of which were observed in any part of the gland. It was the dense white material, consisting of minute sub-globular refracting particles, soluble in acetic acid, the accumulation of which in the larger straight tubuli uriniferi constituted the white striæ above mentioned.

Numerous cases of the total absence of one kidney are recorded, for a list of which convenient reference may be made to M. Rayer's work on the Diseases of that Gland. On referring, however, to the particulars of these cases, it will be observed, that, in the majority of them, the deficiency of one gland has been compensated for, by an increased size of the existing one, or that the existing kidney presented, in addition to its abnormal bulk, sufficient evidence, in its irregular form, of its being constituted by the coalescence of two. This coalescence may amount either to complete fusion of the two

glands into one body, or may consist in their simple union by means of a transverse isthmus. Other cases, again, are mentioned in which the size of the existing gland has not exceeded the natural standard, among which the present case is to be classed. In this respect, then, it presents nothing new, and there is every reason for supposing, that had the existing kidney retained its healthy condition, good health might have been enjoyed with one kidney, rather below the average size. But the present instance shows more particularly what a very small portion indeed of secreting structure in the kidney is compatible with tolerable health. As to the predisposing causes of the disease in the kidney, unless the condition of the heart be considered as such, there appears no other obvious one in the present case, excepting the double duty the gland was called upon to perform. The pathological condition of the kidney, and the presence of albumen in the urine, are clearly, in this case, not to be referred to the secretion and deposition of oily matter in the tubuli uriniferi. It affords, on the contrary, an instance of what may probably be considered the effects of chronic adhesive inflammation of the venous plexus and tubuli uriniferi, causing partial obliteration of the former, and contraction and obliteration of the latter, or their infaretion with solid albuminous matter. The latter phenomenon is one so frequently met with in various affections—such as scarlatina, jaundice, and active congestion or inflammation of the kidney from exposure to cold, &c.—that it might, perhaps, be readily admitted as a frequent cause of degeneration of the gland, and which I believe it is. The adhesive capillary phlebitis, which I presume to have been the principal cause of the contraction and destruction of the glandular tissue, is so closely analogous to what occurs in other organs, especially the liver, and which ultimately produces in them cicatriform contraction and induration, that the probable identity of the affection in all these cases may fairly be assumed.

This obliteration of the capillary venous plexus I believe to originate in the formation in those vessels of fibrous clots,

such as are met with in certain circumstances in nearly every part of the venous system, and the probable nature of which, and the circumstances attending their formation in the pulmonary arteries, have been so well described by Mr. Paget, in the two latter volumes of the Society's Transactions; and upon which subject, the cases and observations of Dr. Peacock, in the last volume, also serve to throw very considerable light. In Rayer's work, fibrinous coagula of the kind alluded to, are described and figured as occurring in conjunction with some forms of albuminuria; and I have for several years past observed numerous instances of the same kind in similar cases. This circumstance, and the examination of a great many kidneys affected with granular degeneration, as occurring in the active class of men who come under observation in the Seaman's Hospital, have led me to conclude that this adhesive inflammation of the tubuli uriniferi and venous plexus of the kidney, is, among that class, by far the most frequent cause of chronic albuminuria, and what is termed granular degeneration of the kidney. And I think that the presence of oil in the tubuli uriniferi, though undoubtedly of frequent occurrence, has no direct or necessary influence in the production of albuminuria, for the reason that such an undue secretion of oil by the kidney may exist to a very great extent, without any albumen being present in the urine, as may be observed in certain cases of jaundice for instance; and on the other hand, because albuminuria may exist, and all the phenomena of suppressed secretion of urea be produced, without any oil being discernible in the tubuli uriniferi. I am also inclined to believe, that the deposition of oil in, or, in other words, its secretion by, the kidney, is, in most cases, concomitant with some affection of the liver, by which, the special function of that gland being impeded, the kidney acts, as it were, vicariously, and eliminates some of the carbonaceous matter which should have been eliminated by the liver in the form of oil, &c. That the kidney, in case of jaundice, assumes this vicarious action, is sufficiently obvious, and that the bile is actually secreted in the epithelial cells of

the tubuli uriniferi, may also be distinctly seen. In other cases, however, the cause of the kidney secreting oil may be traced, perhaps, to pulmonary disease, and in these cases also it is to be looked upon as a vicarious action.

ON A

PARTICULAR DERANGEMENT

OF THE

STRUCTURE OF THE SPLEEN,

By J. B. S. JACKSON, M.D., Boston, U.S.A.

Communicated (with some introductory remarks and comments)

By THOMAS HODGKIN, M.D.

Received June 23rd—Read June 23rd, 1846.

In 1832 I presented to this Society a short paper, in which I described some pathological appearances which I had noticed in the spleen, and which, I believed, had not been previously made the subject of observation. One of these consisted in a partial, well-defined alteration of texture, which I was induced to attribute to the extravasation of blood caused by local injury. When Professor Rokitanski was in this country, about three years ago, I took an opportunity of bringing some specimens, exhibiting this derangement, under his inspection. He immediately recognized it as one which had been the subject of his own investigation; but, instead of adopting my view as to its local origin, he regarded it as one of the effects of endocarditis, and as produced by the poisoned condition of the blood. Though it was easy to understand that an altered condition of the blood might affect the general structure of the spleen, producing the softened consistence and lilac colour which we find in many subjects who have died of fever, I confess that I was sceptical as to the necessary connection between the altered condition of the blood, and the partial, circumscribed, permanent degeneration, nearly uniform in situation, which is seen in the cases referred to. At the same time I could not doubt the accu-

racy of the Professor's facts, which indicated a remarkable coincidence, even if they did not furnish a satisfactory explanation.

I have recently received a letter from my friend Dr. Jackson, of Boston, in the United States, in which communication he gives his own observations on this derangement.

Dr. Jackson is a most laborious and practised pathological anatomist; and the cases which he has adduced, afford so strong a corroboration of the coincidence pointed out by the Professor of Vienna, that it affords me pleasure to lay them before this Society, and thereby supply one of the deficiencies of my former paper. I do so in the Doctor's own words.

"I have met with a series of cases of the disease described in your Catalogue of the Museum at Guy's Hospital as a partial and circumscribed degeneration of the spleen. There are some appearances, however, in the cases which I have observed, which will, I think, either throw some light on the nature of the disease, or show it to be something quite peculiar. The whole number of cases is nine. The disease is found in regular masses, varying from one quarter of an inch to one inch in diameter; and generally, several were found in the same organ. These were situated in the edge, or very near to it, and not upon the two broad faces of the organ; and they appeared to extend from the surface into the substance of the organ, being never, I believe, found in the substance without coming to the surface. They were perfectly defined, and often surrounded by a little loose, cellular tissue, but were never encysted. The colour was the striking characteristic. It was always more or less yellow, except in one case, where it was evidently stained with blood; sometimes a faint yellow, but more generally bright. In one case it is described as an 'ochre;' in the second, as a 'gamboge,' (i. e. gamboge when moistened by water); and, in a third, as being of a bright golden yellow colour, contrasting strongly and very beautifully with the deep red colour of the rest of the organ. Sometimes, in the less perfected specimens, there

was an intermixture of red. The masses are perfectly opaque, the cut surface is smooth, and generally they are of the consistence of fibrin; blood-vessels were distinct in some specimens, but generally they could not be seen. The surface of the organ corresponding to these masses was opaque, the yellow colour showing through, more or less, from beneath; but, in one case, the disease was only marked externally by a deep red colour; the whole surface was sometimes depressed, and sometimes not at all so, but more frequently there was a narrow depression around the limits of the disease; old peritoneal adhesions were sometimes found in this part. The spleen itself was generally noted as of the usual size. In one case it was small; in one, rather large; in another (the patient had formerly had intermittent fever), it was so much enlarged as to weigh 1 lb. 6¾ oz. avoirdupois. Nothing was ever seen in the organ like tubercular or malignant disease, nor was there any trace of pus either in or out of the diseased masses. In one case only was there anything like acute inflammation (and perhaps this was not), the substance of the organ being, in three different places, firm, quite friable, and of a dark red colour, as compared with the rest of the organ. All of the patients were adults except one, who was a lad ten years of age. You have observed the disease described by yourself, principally, if not exclusively, in males;* but, in my cases, females were the subjects, and in a large proportion. You are inclined to regard it as the effect of external injury, and the same opinion I find expressed in your paper in the Medico-Chirurgical Transactions (vol. xvii. p. 99); but, in my cases, no allusion is made to any such explanation, the fact being overlooked, if it existed, as I was not aware, at the time of your observations. In five of the cases it is expressly stated that there were no tubercles in the lungs,—an interesting point, as bearing on the nature of the disease of the spleen;

* The occurrence of the derangement in males was noticed in the Catalogue of the Museum at Guy's. Amongst the other cases related subsequently in the Transactions of the Medico-Chirurgical Society, some are instances presented by females.—T. H.

in two, who died of anything but pulmonary complaint, the fact is not noticed; in one, there existed a few latent tubercles; and one patient only died of phthisis. Most of the patients died of complicated organic disease; three of organic disease of the brain; one of cancer of the uterus; one of cerebral affection after scarlatina. One thing, however, was common to every one of the nine, whatever was the disease that caused death,—and that was, an organic disease of the heart; and, in five of the nine, there were found vegetations upon the valves; in one of these last there was fibrin adhering to the inner surface of the left auricle, and becoming organized; in another (not one of the five), there was, in the appendix of the right auricle, a mass of fibrin as large as the top of the thumb, and completely infiltrated with pus, as some would say; in one of the five cases of vegetations of the valves, there was also arteritis, i. e. the iliac and femoral arteries were plugged up by fibrin. This fact of a tendency to coagulation of the blood in the cavities of the heart, in connection with disease of the organ, has struck me as particularly interesting, and I have long desired to communicate the observations to you, in order to have your opinion. My inference was, that, in the cellules of the spleen, something of the same kind took place, analogous also to the arteritis above mentioned. You explain it by an effusion of blood, either spontaneous or the result of external injury; but I should have mentioned above, that in no one of my cases was there the slightest appearance of recent effusion, nor a trace of ecchymosis. It is a singular coincidence, that all of these cases were seen several years ago, and I have not, since then, met with a single one."

In a second letter which Dr. Jackson has written to me on this subject, he says,—" Since I wrote to you I have met with two other cases of disease of the spleen, such as those before described, both in dissecting-room subjects. One had extensive vegetations on the aorta and near to the mitral valves. The other had no disease of the heart, and this is the first exceptional case. One had a deep red ecchymosed appear-

ance just above the diseased mass in the spleen, and this was altogether the nearest approach to apoplexy that I have ever met with."

On referring to the cases noticed in my paper on this derangement of structure, and to some others which have since fallen under my observation, I find that some affection of the internal surface of the heart was present in a considerable number of those examples, but that, in a few, the heart is expressly recorded to have been healthy.

My friend, Dr. Seth Thompson, has informed me that, so long ago as the time of his visit to Vienna, in 1837, Professor Rokitanski used to point out in close relation to this affection of the spleen, a very similar derangement of the structure of the kidney, which he also ascribed to the influence of endocarditis.

This derangement has likewise been seen and recorded by myself. It is mentioned in one of the cases published in the 17th volume of the Transactions, and in two others which were recorded in late notes.

I also find one case in which the derangement of the kidney was present, without any corresponding lesion of the spleen.

Being at Oxford in the summer of 1832, I examined, in company with my friend, G. Paxton, the body of a patient of his, and of our friend, Dr. Kidd. He was a very stout, elderly man, by occupation a coachman, but reported to have been of remarkably sober habits. He had for some time laboured under dropsical symptoms, with general anasarca. He had had considerable difficulty of breathing, and oppression about the heart. Its rythm is reported to have been rather singular, and to have been accompanied with a purring sound. About a year, or a little more, before his death, he met with an accident, by which he hurt his loins, and he continued to feel inconvenience in that region.

The heart was of enormous size, being both dilated and thickened. Its parietes were rather pale and flabby. Intermixed with the ordinary coagula, were some of a light colour,

pretty firmly adherent to the parietes, and having externally almost a membranous character, though soft and grumous within. The chordæ tendineæ were rather thickened and rigid. The margin of the mitral valve was a little thickened, yet scarcely sufficiently so to interfere with its function. The valves, at their attachment to the ventricular opening, were thickened and partially ossified. The margins of the aortic valves were rather contracted, and a little below their edges there was a small fold, or flap, parallel to the lip of the valve. The lungs were engorged, and slightly emphysematous. The liver was rather large. Its incised surface presented the mottled appearance that has been compared to nutmeg. The tunics of both kidneys were thickened and adherent. In one kidney, a small and defined portion of the glandular substance was somewhat indurated, and of a pale yellow colour. The tunic, where corresponding to this spot, was thickened and adherent. It was probably the result of external violence.

It is rather remarkable, that this case equally supports Professor Rokitanski's opinion and my own.

The occurrence of a similar affection in two organs so dissimilar in structure and function, but so closely associated in situation, appears to me to afford rather stronger support to the idea of a local, than to that of a general cause. Yet, with this prepossession in my mind, I cannot but attach importance to the opinion and observation of Professor Rokitanski, supported as it is by the independent evidence of Dr. Jackson, and also by a large proportion of my own examples. I see no reason against admitting the operation of both the suspected influences. To the affection of the heart itself, and probably to the state of the circulating fluid also, may be ascribed such a condition of a part well supplied with blood, as would render it very susceptible of extravasation from the application of violence, though it may have been so slight as to make no impression on the memory of the patient, or to allow his attention to be turned from it by circumstances of greater apparent moment.

ON A

LUMINOUS APPEARANCE

OF

THE HUMAN EYE,

AND ITS APPLICATION TO THE DETECTION OF DISEASE OF THE RETINA AND POSTERIOR PART OF THE EYE.

By WILLIAM CUMMING,

LATE HOUSE-SURGEON TO THE LONDON HOSPITAL.

Communicated by T. B. CURLING,

ASSISTANT-SURGEON TO THE LONDON HOSPITAL.

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The luminous appearance of the eyes of cats, dogs, rabbits, oxen, sheep, and other animals, has been long known, and referred to the reflection of light by the tapetum; as also the reflection from the eye of the Albino, the reflection produced by morbid deposits in, and other changes of, the retina; and from the deficiency of pigment in persons not Albinoes.

Müller, (page 93, by Baly,) in a paragraph on the development of light in the higher animals, says, "The luminous appearance of the eyes of some animals arises from the reflection of the light from a brilliant tapetum which is devoid of black pigment; for which reason the eye of the white rabbit is especially brilliant, and the eyes of the Albino Sachs are said to have been luminous. Prevost was the first to explain the phenomenon: he showed that it could never be seen in complete darkness, and is dependent neither on the will, nor on the passions, but is the effect of the reflection of light which enters the eye from without."

Beer has described a peculiar reflection from the eye accompanying some cases of amaurosis. The cat's-eye amaurosis, "he considers it always confined to old, dwindled, grey-headed subjects, or unhealthy young subjects. When the patient is bereft of vision, a concave, pale grey, bright yellowish, or variegated reddish opacity, is developed. In a half darkened place such an eye presents a shining yellowish or reddish appearance, but only in certain positions of the eyeballs, whence Beer termed it Cat's-eye amaurosis. The disorder is also not accompanied with any other essential morbid appearance, except the decline of vision or complete blindness."—Cooper's Surgical Dict., article Amaurosis.

The late Mr. Tyrrell refers to a brilliant metallic reflection perceived through the pupil in some cases of amaurosis. He says, "Latterly we have observed that the metallic appearance exists in a degree in very many cases of organic amaurosis; but that it is rarely detected unless especially sought for: we have perceived it in cases in which amaurosis has been imperfect, as well as in those in which vision has been perfectly lost. In some instances, in which we have detected this metallic appearance, the patients have experienced muscæ and sparks, or flashes, indicating disease of the choroid or retina; but in some cases the vision has been gradually lost without peculiar symptoms or suffering."—Tyrrell, vol. ii.

These extracts point out the cases in which reflection from the posterior part of the human eye has been observed; none of them mention a reflection from the posterior part of the perfectly-formed and healthy eye of the human subject: nor have I found or heard of any author who has described one. The object of the present paper is to show that the healthy human eye is equally or nearly equally luminous as the eye of the cat, dog, &c., when observed under favourable circumstances, and the application of the abnormal appearance, or want of, this luminosity, to the detection of changes in the retina and posterior part of the eye.

The reflection from the posterior part of the human eye may be seen in the following manner: Let the person whose

eye is to be examined be placed at the distance of ten or twelve feet from a gas or other bright light; the rays of light must fall directly on his face; all rays passing laterally of his head must be intercepted by a screen, placed half way between the light and the eye examined. If the reflection be bright, it will be at once seen from any spot between the light and the screen.

The following observations were made in two rooms; in one of which was a gas-light, the other completely darkened. The person whose eye was to be viewed was placed in the dark room, five feet from a half-closed door opening into this room; he directly faced the light, also at the distance of four or five feet from the door.

The appearance of the reflection was in most cases extremely brilliant when seen from a position between the door and light. In some it was at once obvious with the door wide open; in others it was seen with great difficulty, and not till every ray of light passing to the side of the iris was carefully intercepted by the door on one side and the hand or a book on the other. The reflection was always seen much more readily and brilliantly when the eye was turned slightly to the side, and the rays of light passed through the pupil obliquely. On passing to the other side of the door, the luminosity was seen with greater difficulty. In this position it is necessary to have the eye turned to the side, to exclude all rays by the hand except those passing directly to the eye. In this way the reflection may be seen distinctly at the distance of eight inches.

In the majority of cases, however, it may be seen as follows: Let the person under examination sit or stand eight or ten feet from a gas-light, looking a little to the side; standing near the gas-light, we have only to approach as near as possible to the direct line between it and the eye to be viewed, at once to see the reflection. Or, in a dark room, a candle being placed four or five feet from the eye, if we approach the direct line between them we shall be able at once to see it in many cases. If solar light be admitted through a nearly-closed

shutter into a dark room, the luminosity may be seen when the pupil is tolerably dilated, the patient standing five or six feet from the aperture, and the observer occupying the position before indicated.

These then are the circumstances necessary for seeing the luminosity. a. That the eye must be at some distance from the source of light; the distance being greater in proportion to the intensity. b. That the rays of light diffused around the patient (and sometimes around the eye itself) should be excluded. c. That the observer should occupy a position as near as possible to the direct line between the source of light and the eye examined; hence it is sometimes necessary for the observer to stand obliquely, that his eye may approach nearer to the direct line.

The appearance of the reflection itself not only varies much in colour and intensity in different persons, but also from the circumstances under which it is seen, viz. the greater or less intensity of light, the position of the eye examined, and the distance at which it is viewed.

When the reflection is seen under the influence of a dim light, as that from a candle, or a few solar rays, a red lurid glare, like that from a dull coal fire, is observed, evidently proceeding from the bottom of the eye, and, though not distinctly concave, yet conveying the idea of concavity. The character of the reflection thus seen by a faint light, at the distance of two or three feet, is very uniform, and does not present much variety of tint.

When the eye receives rays from a good bright light ten feet distant, and we stand near the light, the reflection is then seen extremely brilliant; presenting a fine metallic lustre, and varying from a bright silver or golden, to a decided red tint: the latter being the more usual colour. While viewing the reflection at this distance, it sometimes undergoes a distinct change, suddenly altering from a copper or red colour, to a silver tint: this happens sometimes in consequence of a slight movement of the eye, but not unfrequently is observed without any movement having taken place.

Although the reflection is more readily seen in an eye with a large pupil, its lustre does not depend upon this circumstance. In two eyes with pupils of equal diameter, the intensity of the reflection frequently varied greatly. In one case, in which the reflection was very dusky in appearance, and the pupil small, atropine was dropped into the eye. I then observed that, though the extent of luminosity was increased, it still retained the same dusky hue. The greater facility with which the reflection is seen when the eye is directed slightly away from the light, appears to depend on the more patulous condition of the pupil.

On approaching within a few inches of the eye, the reflection is not visible, for, before our eye can be brought within range of the reflected rays, the incident rays of light are excluded. On placing before the eye examined, a black card with an aperture the size of the iris, the intensity of the reflection was observed to be somewhat diminished.

In cases in which the lens had been removed, the reflection was indistinct at a distance, but was rendered somewhat clearer by the aid of a double convex lens placed before the eye examined; but at two or three feet distant, the reflection was as obvious as in cases in which the lens was present.

Among the cases I have examined, I have recorded indiscriminately the appearance of the luminosity in twenty persons with good and perfect vision, whose ages varied from a few months to sixty years. In sixteen cases the reflection was bright and very evident; in four, faint, and seen with difficulty; and in one it was not seen at all; in the last case, the pupils remained small in the shade. If these observations are confirmed by other observers, we may say that the reflection ought to be seen in every healthy eye with a good-sized pupil.

Having pointed out the character of this reflection, and the mode in which it may be seen, we inquire its source or cause.

The retina in the living eye is a perfectly transparent medium in contact with the choroid and vitreous body. The

transparency of the retina is, however, no proof that it does not itself reflect many of the rays of light that impinge upon it, although the greater proportion are transmitted; the transparency of a structure being quite consistent with considerable reflection, but not with absorption of the rays of light: and this reflection would be rendered more obvious by the position of the choroid. The formation of images upon the retina, acknowledged by all, is at once a proof of its reflecting power.

From these considerations, and the fact of the anterior layer of the retina consisting of a vascular plexus, and thinking the choroid with its pigment too dark to give such a reflection, my first impression was that the retina was the reflecting surface.

Mr. Bowman, however, having suggested to me the greater probability of the choroid with the pigment being the reflecting structure, I commenced some experiments to determine this point. The reddish brown colour of the pigment of the human eye has been fully recognised. Mr. Hunter clearly and fully points out the varieties in the depth of tint of the pigment. Entirely or almost wanting in the Albino, it is of a light brown or fawn colour in fair persons, while in persons of swarthy complexion it is proportionably dark, appearing to keep pace with the depth of colour of the rete-mucosum; being still darker in mulattoes and negroes.

The brilliancy of the luminosity of the healthy eye appears to be in proportion to the light colour of the pigment. So evident is the reflection in the Albino, that in ordinary daylight the pupils present a reddish appearance. On placing a middle-aged man, an Albino, ten or twelve feet from a gaslight, the reflection was extremely vivid, and of a pinker colour than ordinary, while the light transmitted through the choroid and iris evidently increased the effect. On placing close to his eye a black card with an aperture a little larger than the pupil, the reflection was little brighter than that from the eye of a fair person examined side by side, but was of a more decided pink colour.

In persons of fair complexion and blue or grey irides, it is generally more brilliant and more readily seen than in those of dark skin and irides. In the mulatto it is also dusky; but in them, as in persons of swarthy complexion, a silvery reflection is sometimes seen, and is most probably a reflection from the retina. In the Albino, this reflection produced by the vascular choroid is most brilliant and lightest in tint, and, in proportion to the darkness of the pigment, its lustre is diminished, and the colour becomes more dusky.

The posterior segment of an eye, the pigment being of the usual brown colour, was exposed to light concentrated by a lens upon it, and a brownish red reflection, of metallic lustre, was observed.

I found, on holding an eye with the optic nerve towards the light, and looking through the pupil, that the light passing through the choroid was of a brilliant red colour, precisely resembling that reflected during life. I therefore obtained seven more eyes, each from a different subject, and found that the same red light was transmitted through the choroid. These cases, taken indiscriminately, leave no doubt that this is an appearance common to the human eye. Some months before, my friend Mr. Dixon showed me an eye in which the same appearance was seen; at that time, however, we both supposed that this was an exception.

This appears to me to be the best proof that the reflection is from the choroid with its pigment, viz., the exact resemblance of the rays transmitted through it to the reflection. But while I regard this as the principal reflecting structure, the light returned from the retina and concavity of the hyaloid body would doubtless increase the effect.

I have not yet seen the luminosity in the dead eye, but the non-injection of the choroid and loss of transparency in the retina sufficiently account for this.

The reflection from these structures would be considerably increased in brilliancy, from the concentrating influence of the concave shape of the retina, and the focal distance of the lens.

The establishment of the fact of a similar reflection from the healthy human eye to that from the eyes of animals, appears to me chiefly important in its adaptation as a mode of examining the posterior part of the eye. The retina and choroid hitherto concealed in the living eye, and little opportunity being afforded of examining their condition after life, in consequence of their diseases not terminating fatally, considerable uncertainty has attended the diseases ascribed to these structures; but the existence of this luminosity having been recognised, its non-existence, or abnormal appearance, may enable us to detect changes in these structures heretofore unknown, or satisfactorily to see those which we only suspected. If we dilate the pupil by atropine, we have a means afforded of seeing the condition of the retina and choroid in every case. The cases I have examined in this way have confirmed the general impression that the retina is not frequently the seat of change in amaurosis; for, out of several cases of amaurosis, in which the non-opacity of the cornea, lens and humours allowed this mode of examination, I found but two in which the retina was so changed that the reflection was not seen. Before, however, relating these cases, I shall make a few observations on the disease called Cat's-eye amaurosis.

Cat's-eye amaurosis.—The recognition of this normal luminosity of the eye will aid us to a clearer understanding of the somewhat contradictory and unsatisfactory statements concerning cat's-eye amaurosis.

First described by Beer, and subsequently by other ophthalmologists, it is confessedly a rare and equivocal disease, and the statements of ophthalmic writers are at variance, not only upon the appearance of the reflection, but upon the progress of the disease, the accompanying symptoms, and the age at which it occurs.

Beer says, that "A pale grey, or whitish yellow opacity, sometimes with a reddish cast in certain lights, is developed in the bottom of the globe far from the pupil; the sight is not merely weak, but in the strictest sense confused, for all ob-

jects, particularly those of smaller size, seem to run together when the patient attempts to survey anything attentively. As the disease proceeds, the bottom of the eye becomes clearer and more visible, and the colour of the iris paler, the latter change being particularly obvious in dark eyes. When the sight is completely extinguished, we may discern, on close inspection of the pupil, a fine vascular network over the opacity, being apparently the ordinary ramification of the arteria centralis retinæ, rendered visible on the shining opal-like fundus of the globe. Such an eye, when seen in particular directions, has a yellowish or reddish luminous appearance in twilight, resembling in some degree that of the cat, whence I have derived the name."*

After an attentive perusal of this passage by Beer, and the description of cat's-eye amaurosis by other ophthalmologists, I am inclined to think that two different things have been confused under this name.

First, that in the majority of cases, the normal luminosity of the eye was observed. When Beer says, that an eye seen in particular directions has a yellowish or reddish appearance in twilight, resembling the eye of a cat, he precisely describes the appearance of the healthy human eye in certain positions; the pupil being dilated, and light falling upon it in a certain direction; and the plate he gives of this affection (vol. ii. plate 4, fig. 1) precisely corresponds with the reflection when observed at a distance of two or three feet. Mr. Tyrrell's account, before alluded to, agrees not only in the appearance of the reflection, but the circumstances under which it was seen are necessary to see the normal luminosity. No one can read his case 90, and observe the reflection of the healthy eye, and not be persuaded that they are one and the same. The first case in which I observed this natural brilliant reflection I supposed to be a case of cat's-eye amaurosis, so accurately did it coincide with his description. Carrying the observation further, I found that it existed in all healthy eyes when the pupils were dilated. Most of the

* Lawrence, p. 519.

cases appear then to have been nought but the observance of the natural luminosity; and that it should be seen in cases of amaurosis only is nowise strange: the more minute examination bestowed upon cases of this kind, the probably dilated state of the pupil, and possible absorption or non-secretion of pigment after continued amaurosis, are reasons why it should have been seen in amaurosis alone—thus it has been associated with various symptoms. One author has found it occur in youth, another in old age.

Next; with these another class of cases has been confounded. Thus, Beer says, "When the sight is completely extinguished, we may discern, on close inspection of the pupil, a fine vascular network over the opacity or shining opal-like fundus of the globe." Mr. Lawrence's cases agree nearly with this description. Red vessels were seen in some cases, and the margin of the reflecting surface was distinctly traceable. The facility with which such reflection was seen, the presence of dilated vessels, and the existence of a margin to the reflecting surface, mark them as differing widely from the former cases. These were cases in all probability of deposit of lymph in the retina. A case of this kind is recorded by Mr. Tyrrell (Case 80, page 125); but discriminated from his account of cat's-eye amaurosis. While, therefore, the latter cases afford conclusive evidence of change in the retina or choroid, in the former cases the existence of the normal luminosity warrants the conclusion that these structures were healthy. If this be a correct analysis of these cases, the mystery that hangs about cat's-eye amaurosis vanishes; the first class of cases were cases of amaurosis arising from cerebral and other causes, in which the retina and choroid being perfect, the normal reflection from them was seen; the second division consists of cases of deposit of lymph or other substances in or about the retina. It is then at once evident that a mere luminosity of the eye will in no case be a sign of altered condition. It will be necessary first to become acquainted with the normal reflection—its modifications in different lights and positions, and at various periods of life, and

in persons of a dark or fair skin; then by the detection of an altered condition of such reflection (and assisted in many cases by contrast with the opposite eye), or by its entire absence, we possess a means of diagnosis in retinal and choroidal disease.

In confirmation of its value, as a means of detecting changes in the retina, I shall now relate a few interesting cases which occurred at the London Ophthalmic Hospital; which I am permitted to do by the kindness of the surgeons of that institution.

Case 1.—Amelia Flemming, ætat. 57, has had bad health for many years, being afflicted with what she calls rheumatism of the head, but has never suffered from gout. Latterly her health and strength have much improved. After getting wet, she saw numerous black spots and bright sparks, which, she says, were only seen by the left eye, and describes as being all situated in the nasal division of the field of vision. She had no giddiness or unusual pain in the head. When she applied at the hospital in April last, three weeks after the first appearance of these symptoms, this was the state of vision with the left eye, its axis being directed straight forwards. The hand, or any other object, was not at all seen when held to the nasal side of the cornea; upon carrying it across to the temporal side, it was at once recognized, and, in this position, large printing was distinguished as black lines. The pupils were equal and small. Atropine was dropped upon the conjunctiva of the left eye; the pupil dilated well, and the following was the state of the reflection when the eyes were examined in the manner before described: upon her looking straight forward, but little light issued from the left eye; less than from the right, the pupil of which was undilated. When she looked to the right, and the right portions of the retinæ were brought under view, the reflection was of its usual brightness, and equal in both eyes; on looking to the left, no reflection was seen from the left eye; that from the right was of its usual lustre. This observation was made without any recol-

lection of the side on which vision existed. In this case the probability was, that it was an affection of the retina; but there was no other sign on which to rely but the statement of the patient with regard to the appearance of scintillations. The pupils were equally black, and the appearance of the eye normal; by this mode of examination it was rendered clear that the left half of the retina had undergone considerable change, and probably its power of transmitting the influence of rays onwards to the cerebrum.

Case 2.—John O——, ætat. 42, a silk-weaver, has always had indifferent health, and bears a cachectic, worn aspect. Three years and a half ago he had primary, followed by secondary, syphilis; he then had an attack of severe inflammation in the right eye, for which mercury was given, and the vision recovered so far that he could read. One year after, large black spots appeared before the same eye, followed by bright sparks both in the light and darkness; he had no pain, and vision was quickly lost, and has remained the same ever since; he cannot do more than distinguish a bright light, except that if an object be held far to the right, almost out of the range of vision, he can partially see it. The pupils were clear, dark, and readily dilated. Lens perfectly transparent. The reflection from the left retina was perfect and brilliant at a few feet distant; here no reflection could be seen from the right eye; on approaching more closely, and looking very carefully into the eye, when it was turned towards the nose, one spot behind the iris was observed to be luminous, corresponding to the only part of the field of vision in which he had any power of distinguishing an object.

Case 3.—Thomas P——, ætat. 29, a driver, received a blow by a hand upon the right eye and margin of the orbit. Upon blowing his nose ten minutes after, the upper eyelid swelled and closed the eye; he applied a leech, the swelling subsided, and he saw perfectly well with the eye. The accident happened on Wednesday, February 11th. On Friday night, an

attack of severe pain came on, with swelling of the eyelids; the eye was closed; pain became excruciating, situated entirely in the orbit, and unaccompanied with scintillations. He was bled and leeched; an opening was made through the upper lid, and pus escaped. On partial recovery, he applied at the London Ophthalmic Hospital. All pain had then ceased; the globe was much protruded, and vision entirely lost.

March 12th.—The globe had resumed its normal position, and its movements were perfect. The right iris was inactive when the eye was exposed alone to the light, but acted freely when the left was stimulated by light. The pupil was clear and black. There was not the slightest perception of the most vivid flame.

The cause of the total loss of sensation in the retina was, in this case, a most interesting inquiry. If it had resulted from mere concussion of the retina, it should have happened at once; it therefore appeared to depend upon the retina having been impaired and its functions destroyed by the succeeding inflammation, or upon the inflammation of the cellular tissue of the orbit having involved the optic nerve, and so far to have damaged it as to entirely prevent the transmission of nervous influence from the sound retina. The absence of scintillations and circumorbiter pains went far against the presumption that the retina had been inflamed, and this was shown not to be the case, by examining the eye in the manner before described, when the reflection was found to be extremely brilliant and equal in both eyes, clearly showing that the retina and vitreous body were in their normal condition. The only remaining explanation of the case was, that the optic nerve itself had been involved in the inflammation.

Case 4.—P. P——, ætat. 27, a bricklayer's labourer, had a severe attack of inflammation of the eyes two years ago; after recovery from this, which did not affect the sight, the vision began gradually to decline; he had no pain in the head, no muscæ or bright sparks before the eyes. He can

now only distinguish light from darkness; the pupils are irregular, and slight opacities on the corneæ give evidence of previous inflammation in the anterior part of the globe. The reflection from each retina is of its normal brightness.

In the first and second cases, the loss of the reflection showed some ocular change; we can suppose this to result from several causes—an extensive change in the choroid; deposits in its structure, of dark matter, or obliteration of its vessels; a slight loss of transparency in the retina, which would not be detected after death, in consequence of this membrane always becoming opalescent shortly after the extinction of life, would destroy the reflection; and this appeared to be the most probable lesion in these cases.

Case 4 is one among several cases of cerebral amaurosis in which the reflection was perfect.

ACCOUNT OF A CASE

IN WHICH

AN ABSCESS IN THE NECK

COMMUNICATED BY AN ULCERATED OPENING WITH THE ARCH OF THE AORTA,

AND IN WHICH THE HÆMORRHAGE DID NOT PROVE FATAL IN LESS THAN FORTY-EIGHT HOURS.

By GEORGE BUSK,

SURGEON OF THE HOSPITAL SHIP "DREADNOUGHT."

Received June 18th—Read June 23rd, 1846.

On the 1st June 1846, I was requested by Mr. Sturton, the Parish Surgeon of Greenwich, to see a woman in the Union Workhouse, in whom considerable hæmorrhage had occurred, from an ulcerated opening in the neck. He had been called to the patient about 4 A.M. on the same day, and was informed that the bleeding had commenced suddenly about an hour previously, and without any apparent exciting cause. He found that it proceeded from a small fistulous opening in the lower part of the neck anteriorly. The woman had lost a considerable quantity of blood before he saw her, and very slight pressure sufficed at that time to stay the flow. As I was unable to see the case before the evening, I recommended that in the mean time a graduated compress should be retained upon the opening. In the evening I found that no further hæmorrhage had taken place.

On removing the bandage and compress, I observed, exactly in the mesial line of the neck in front, and close above

the upper edge of the sternum, a funnel-shaped hollow, about an inch and a half across, lined with the common integument down to the bottom, which presented a fistulous opening about one-eighth of an inch in diameter, and in this opening were visible some small florid granulations. The whole presented very much the aspect of an old callous fistula in which it might be supposed a tracheal cannula had been long worn. There was however no communication with the windpipe.

The parts surrounding the fistulous opening were thickened and consolidated.

At first, after removal of the compress, I was unable to obtain any discharge from the opening even by pressing with considerable force, in its neighbourhood, and I thence concluded that the cavity, if there were one, with which the opening communicated, passed under, and was protected from pressure, by the sternum and clavicles. At first, neither blood nor pus escaped, but, upon the woman being desired to cough several times, the funnel-shaped hollow became suddenly filled with arterial blood, which welled up continuously from the bottom, and not in jets; but upon more close inspection it could be seen that it rose with indistinct intermissions. The bleeding though slow was sufficiently copious to be alarming, and was immediately and readily stayed as before, by slight pressure with a compress and bandage.

The patient was a woman about thirty-five years of age, moderately stout, and well formed. She presented no marks of scrofulous disease in the neck. She was pale from the hæmorrhage, and became faint when placed upright for a few moments. The account she gave of her case was this: that for about fourteen years she had perceived a small hard "lump" in the hollow of the neck, and in the situation of the existing fistulous ulceration, from which swelling she had, however, never suffered any pain nor even inconvenience, until her admission into the Greenwich Union, about six months previously. Soon after this, the swelling in the neck inflamed and suppurated. The abscess was allowed to open spontaneously, which event had occurred about five months

before the present time. On bursting, it discharged a large quantity of *white* matter, and had continued to discharge such ever since, sometimes in considerable quantity. This constant discharge constituted all the annoyance she experienced from the affection, her breathing never having been impeded, nor had she ever any cough.

The hæmorrhage did not recur till the following morning, when blood was observed to ooze through the bandages; and a neighbouring surgeon, Mr. Bradley, being called in, removed the compress, upon which the blood was ejected in a jet which rose above his head. He immediately stopped the orifice, and the external flow of blood, which appeared then to fill the cavity of the abscess, and to cause considerable swelling of the lower part of the neck, and supra-clavicular regions, attended with a diffuse pulsation like that of an aneurismal tumour:—this was the first occasion of any pulsation being perceived in the neighbourhood of the fistulous opening. The sudden gush of blood exhausted the already feeble powers of the woman, and she continued to sink, partly also perhaps in consequence of the continued internal bleeding into the cavity of the abscess, till about 3 A.M. on the morning of the 3rd of June, when she expired; about forty-eight hours from the commencement of the hæmorrhage.

The body was examined the same day. On moving it upon the table, a large quantity of semi-fluid and extremely fetid grumous coagula escaped from the opening in the neck, and a still larger quantity was expressed from it. The ulcerated opening above described was found to communicate with a large irregular cavity filled with extremely fetid coagula. The cavity, when cleared of the clots, presented the appearance of an old abscess. The internal surface was very uneven, ragged, and flocculent, and the walls, of unequal thickness, were formed by the consolidation of the tissues immediately adjacent, and in this thickened mass were imbedded some enlarged glands, which however presented no trace of scrofulous deposit. The hollow was of great capacity, and it contained at

least a pound of coagulum. It occupied nearly the whole front of the neck below the thyroid cartilage, being bounded *posteriorly* by the trachea, which was covered with a thick deposit, and in front the walls were formed by the integuments and fascia, and the atrophied expansions of the sterno-thyroid and hyoid, and partly of the sterno-mastoid muscles. The cavity extended on the right side downwards and backwards between the right bronchus and the arteria innominata, behind the root of the right lung, (the apex of which was solidified by the compression,) to the front and right side of the bodies of two or three of the upper dorsal vertebræ, the ligamentous tissue covering which, formed, as it were, a portion of the walls of the abscess; and the bone, though not exposed, presented several small exostoses, indicating the considerable length of time the abscess must have extended to that point. Inferiorly, the main anterior cavity of the abscess reached the right side of the arch of the aorta, or rather of the ascending aorta, and for about two inches below the origin of the arteria innominata the external cellular tunic of that vessel, as well as of the greater part of the external side of the arteria innominata, was completely removed. The exposed middle coat was quite bare, and its fibrous structure clearly displayed. In the middle of the denuded portion of the aorta was a small opening or fissure about one-eighth of an inch in length, and the direction of which was oblique, as regards the direction of the vessel. Internally, the lining membrane exhibited at the corresponding point a narrow rent of the same size, the edges of which were sharp, abrupt, and ragged, as if recently torn; and on the immediately adjacent internal surface there was a very thin deposit of fibrine. Immediately within the orifice of the arteria innominata the internal surface of that vessel also presented in a slight degree a similar deposit, and upon holding the part up to the light, the wall of the arteria innominata, where contiguous to the abscess, appeared very thin and transparent, but there was no breach of its continuity. The heart and vessels, except as above, were healthy. The right bronchus presented internally, at a point corre-

sponding to the part where it was crossed by the abscess, a blackened spot and slight roughness of the mucous membrane, similar to that in the arteria innominata.

In the absence of more precise information upon the earlier history of the case, it would be useless to speculate upon the nature of the large abscess above described, which, as far as I can judge, appears to have originated in the lymphatic glands of the lower part of the neck and of those surrounding, especially the right bronchus. The abscess however being once formed, its peculiar situation under the immoveable sternum and clavicles would perhaps be a sufficient reason for its not closing. The case is chiefly interesting as affording an unequivocal instance of a communication being formed between the cavity of an abscess and a large arterial trunk, in consequence of an ulcerative process being set up from without, and going on to produce such a thinning of the arterial tunics, that they finally give way under the impetus of the blood. It is evident that had this communication been set up at an earlier period, and before the bursting of the abscess, it would have been very difficult, if not impossible, at that stage, to have avoided mistaking the abscess for an aneurism; for when, towards the end, the orifice was closed, and the cavity of the abscess filled with blood, such a pulsation was caused, as very strongly to simulate that presented by an aneurismal tumour.

Another point of interest appears to be the length of time the patient survived after hæmorrhage had commenced from the ascending aorta, and the comparative ease with which it was stayed by pressure.

ON THE INTIMATE

STRUCTURE OF THE HUMAN KIDNEY,

AND ON THE

CHANGES WHICH ITS SEVERAL COMPONENT PARTS UNDERGO IN "BRIGHT'S DISEASE."*

BY JOSEPH TOYNBEE, F.R.S.,

ONE OF THE SURGEONS TO THE ST. GEORGE'S AND ST. JAMES'S GENERAL DISPENSARY.

Received April 24th—Read June 23rd, 1846.

PERHAPS no one disease has, during the last twenty years, excited a greater share of attention, or enlisted, in its elucidation, a larger amount of professional skill, than that renal affection which is characterized by a secretion of albuminous urine, and commonly known as "Bright's disease."

Two circumstances sufficiently explain the importance at-

* Previous to entering upon the subject of this paper, it may be permitted me to say a few words respecting the joint labours of Dr. Bright and myself. In the year 1838, having minutely injected a specimen of granular kidney, I perceived that the blood-vessels of the Malpighian tuft were considerably enlarged, and communicated that fact at a meeting of the Westminster Medical Society. Towards the latter end of 1839, I showed Dr. Bright several additional specimens which I had succeeded in preparing in illustration of this view, and received from him a promise of opportunities for further experiment. Accordingly, in the course of 1840, Dr. Bright sent me specimens, accompanied with notes; and during that and the three following years we procured and injected nearly one hundred kidneys, submitting portions of each to microscopic investigation, and carefully noting every matter which seemed of any importance. These preparations are

tached to the investigation; these are the extreme frequency and fatal character of the disease, and the difficulties which attend a satisfactory elucidation of its true nature. This being the case, every attempt which promises to throw any additional light upon the peculiarities of the affection, will, doubtless, be received with satisfaction; in this hope, the following observations are offered.

Of the Anatomy of the Kidney.

1. *The Parenchyma.*—To those who have paid attention to the intimate structure of glands, it is well known that, besides the blood-vessels, ducts, tubuli, and nerves, there are intervascular spaces of no inconsiderable size, which are occupied by a substance that has received the name of Parenchyma. Malpighi, in whose writings, as Professor Owen has truly said, the germs may be found of many of the recent discoveries in physiology, undertook numerous researches into the nature of the parenchyma.

Subsequent to Malpighi, anatomists, misled by the indefinite and unphilosophical writings of Ruysch, appear to have entertained very vague notions of the nature of the parenchyma of glands, and to have regarded it as a mere cellular network connecting together the vessels of an organ; nor do they appear to have suspected that it had any other function to perform. The modern researches of Schleiden, Schwann, and Henle, clearly show that the parenchyma con-

now in my possession. In the year 1841, at Dr. Bright's expense, a series of drawings and engravings was made in illustration of the subject, and of the views to which our investigations had led. Subsequently to this period, various circumstances arose to prevent the issue of a work which had been designed to comprise the results of our joint labours; and I am now indebted to the kind liberality of Dr. Bright for the opportunity of using the illustrations to which I have alluded, and which form a large share of the series accompanying this paper. So sensible, indeed, am I that nearly everything of value which may be contained in the observations which follow, is to be attributed to the assistance of Dr. Bright, that it is not without some degree of diffidence that I venture to prefix my name alone to the present communication.

sists of cells and corpuscles; and recent investigations tend to establish the extreme importance of these cells in the processes of development, nutrition, and secretion. It has been demonstrated by myself that they almost wholly compose those tissues which, in a healthy state, contain no blood-vessels, and in various forms enter into the structure of animal solids.*

By many modern anatomists the parenchyma of glands has been comparatively neglected. Too exclusive an attention has been directed to the epithelial cells lining the walls of the excretory ducts, to which the office of eliminating from the blood the matter to be secreted has been assigned. It should, however, be remembered that many of the blood-vessels of glands, instead of ramifying over the surface of the excretory tubes, are distributed through the parenchyma of the organ, where there is every reason to believe that the blood contained in them is acted upon by the parenchymal cells,—which are known to possess an active function,—being thereby at least prepared for that further change which takes place during its elimination, by the agency of the epithelial cells, in its passage into the interior of the excretory duct.

The relation in which the parenchymal cells stand to the nervous system is a subject of great interest. After numerous dissections which I have made for the purpose of ascertaining the way in which the nervous filaments terminate in the kidney, the only conclusion to which I could arrive is, that the filaments end by becoming continuous with the parenchyma of the organ, precisely in the same way as I have observed those in the tail of a tadpole to become directly continuous with the radiating fibres of stellated corpuscles, and the filaments from the corpuscles to communicate with each other.

When the practitioner observes that a total suppression of urinary secretion follows an injury of that part of the spinal cord from which the kidney appears to derive a portion of its

* Researches tending to prove the Non-Vascularity and uniform mode of Organization and Nutrition of certain Animal Tissues. Philosophical Transactions, Part II. 1841.

nervous power, and bears in mind that certain mental impressions can cause an almost instantaneous formation of other secretions in large quantities, as in the sudden flow of tears or saliva, he can scarcely doubt that every part of these glands is under the immediate influence of the nervous system. Should he proceed to examine the writings of anatomists with the view of understanding the distribution of the nerves through the glands, the only information that will be found is, that the nervous filaments have been traced along the trunks of the larger vessels at their entrance into the organ. I have, however, succeeded in tracing those filaments completely into the substance of a gland, where they accompany the arteries, and, as I have stated, where their extremely minute filamentary radiations have appeared to become continuous with the parenchyma of the organ.

In connection with the above, I am desirous of adding another observation. It has been stated that the parenchyma of glands is composed of corpuscles or cells to which important functions have been assigned. Cells of a character not very dissimilar are seen lining the interior of the tubuli as well as the blood-vessels. So abundant are they in the tubuli as to occupy frequently no inconsiderable share of the internal space; and they might with propriety be denominated *intra*-tubular cells, to distinguish them from the others, which might be termed the parenchymatous or *inter*-tubular cells. In the testicle, the latter description of cells are but very sparingly diffused, being principally found in contact with the blood-vessels, and between them and the tubuli seminiferi; while the former, or those within the tubuli, are, on the contrary, very numerous, and so loosely connected that gentle pressure easily causes separation.

The Tubuli Uriniferi.

The course of the tubuli uriniferi through the central and cortical divisions of the kidney, and their presence even on its surface, were illustrated by Hunter in some injected sections of the kidney of the horse, which are preserved in the

Physiological Gallery of the Museum of the College of Surgeons in London.

Since those preparations were made, several anatomists have succeeded in injecting the tubuli uriniferi of the lower animals. Müller has distended them as far as the surface of the kidney of the horse, in which he says "they anastomose freely." According to Krause, "the urinary canals anastomose with each other, and also terminate by free cæcal extremities, just as is the case with the convoluted tubuli seminiferi."* In the Hunterian Museum may be seen a section of the entire kidney of a rhinoceros, in which I was enabled to inject the tubuli so as to display them in their course throughout the entire organ.†

More recently, Mr. Bowman's excellent paper on the kidney has appeared; and as it refers especially to the anatomical details involved in the present communication, I shall refer occasionally to his opinions in the course of my observations.

To obtain a satisfactory examination of the tubuli uriniferi, it is absolutely necessary that they should be viewed in a distended state, produced not merely by injection of the arterial system, but by a conjoint injection *viâ* the ureter. Subsequent to my injection of the kidney of the rhinoceros, in which the tubuli were filled to the surface of the organ, I have succeeded to the same extent with the human kidney in twenty instances out of one hundred and seventeen specimens which were the subject of careful experiments. It is from an attentive study of these injections that the descriptions which follow have been derived.

Near the apices of the mammillary processes, the tubuli uriniferi are so densely packed together, as to present an appearance of contact; all that intervenes being a small quantity of the parenchymatous tissue, and a few blood-vessels. They may be said to form, at this point, one bundle of tubes. Towards the base of the pyramidal masses, how-

* Müller's Physiology, p. 453, vol. 1.

† Physiological Gallery. In this specimen the arteries are filled with a red-coloured injection, and the tubuli with a white.

ever, this tubular fasciculus divides into a series of smaller ones, separated from each other by couiform masses of blood-vessels, prolonged from the cortex towards which their bases are directed.—(Plate VII. fig. 2.)

All the tubüli lying between the apex and base of the pyramidal mass are very uniform in their dimensions; and though not a few of them, in their course through this portion of the kidney, are bifurcated, yet each branch remains nearly as capacious as the original tube.

Of the tubuli in the cortex.—Immediately on entering the cortical coat, the tubular fasciculi just described, resolve into their component tubes, which thence disperse themselves through every part of the vascular tissue; some taking the direction of the external surface, and others that of the inter-pyramidal spaces. The mode in which the tubuli are distributed in the cortical substance is rather complicated, abounding in tortuosities, plexuses, convolutions, and dilatations, the latter not unfrequently of considerable size. Occasionally a tube, after emerging from the pyramidal mass, makes an abrupt turn, pursues a retrograde course for some distance, and then resumes its original direction. Others proceed towards the surface of the organ, giving out branches by the way, which are often of co-equal capacity with themselves. The nearer they approach to the surface, the more numerous become the ramifications of the tubes, which are not merely continuous with each other, but with those arising from the adjacent tubuli, with which they interweave, and form plexuses. In addition to the plexuses, the tubuli in the cortex exhibit convoluted masses, and at intervals distinct dilatations and loops. A tube, for instance, will divide as it emerges from the pyramidal mass, and with one of its divisions form a loop with a similar branch from a neighbouring tube. Another tube will separate into two branches, which after running for a short distance, reunite. From the circle thus formed, in other cases, a tube will be given off, from which, at a short distance, another will spring, and form a similar loop.—(Plate VII. figs. 1 to 11.)

Fig. 1.

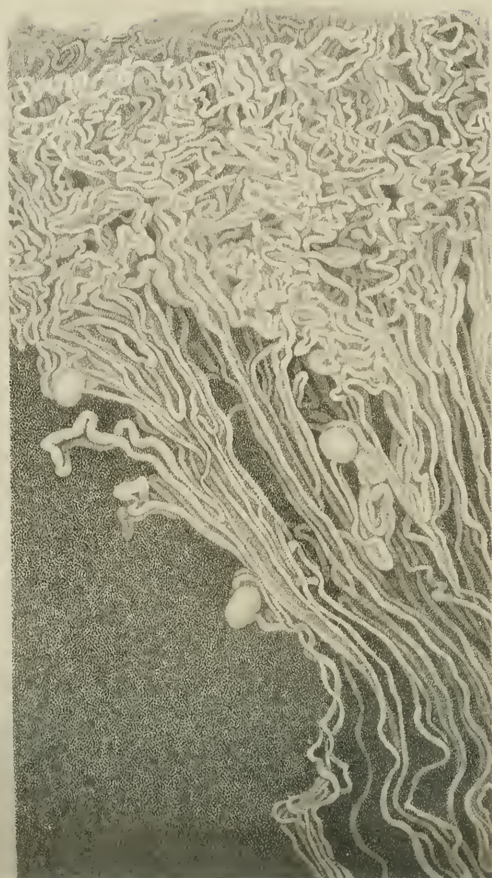
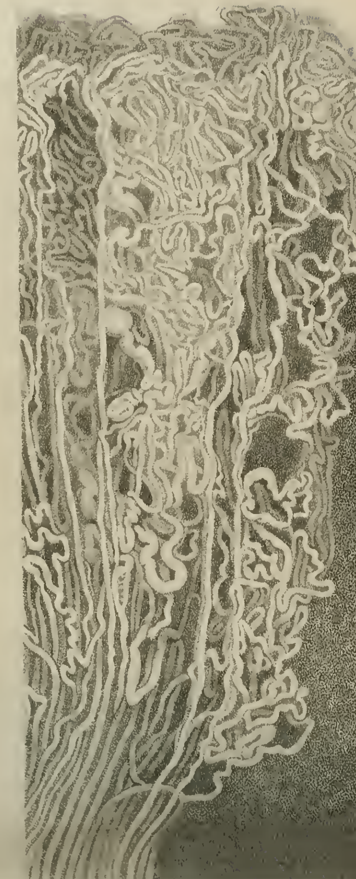


Fig. 6

Fig. 7.

Fig. 8.

Fig. 2



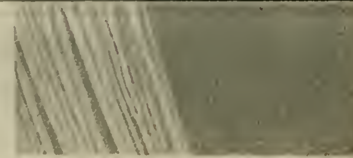


Fig 3

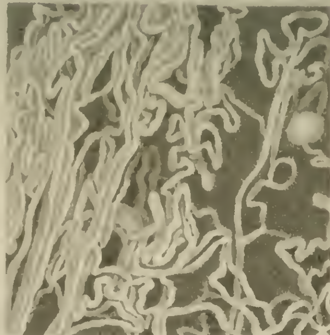


Fig 9

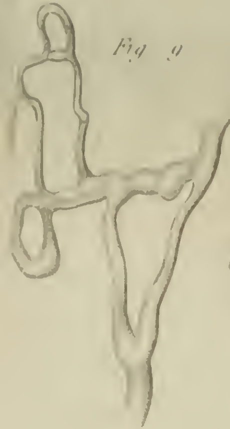


Fig. 11.

Fig. 5.

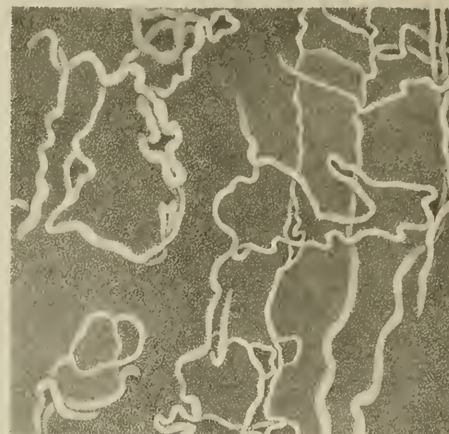


Fig. 4.

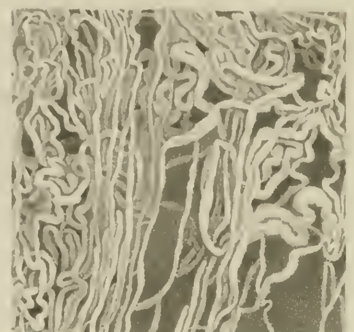


Fig. 10.

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Fig. 1.

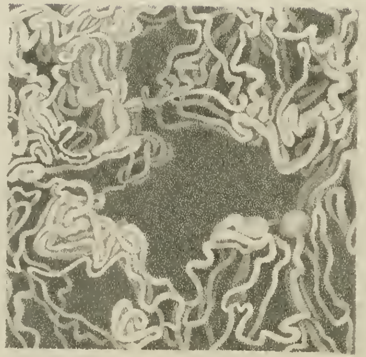


Fig. 7.

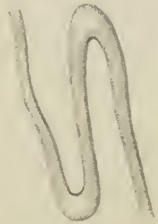


Fig. 8

Fig. 9.

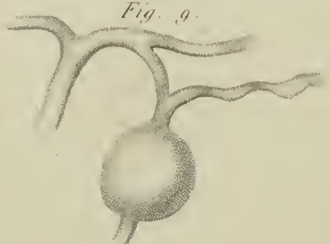


Fig. 2.

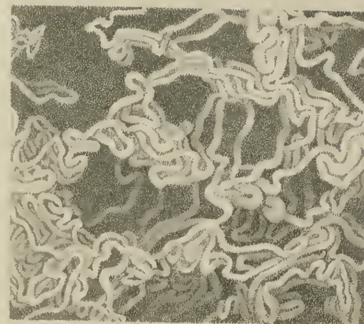


Fig. 3.

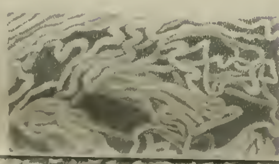


Fig. 10.

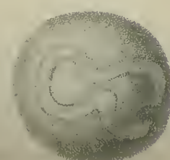
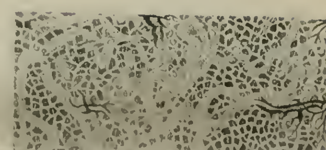


Fig. 4.



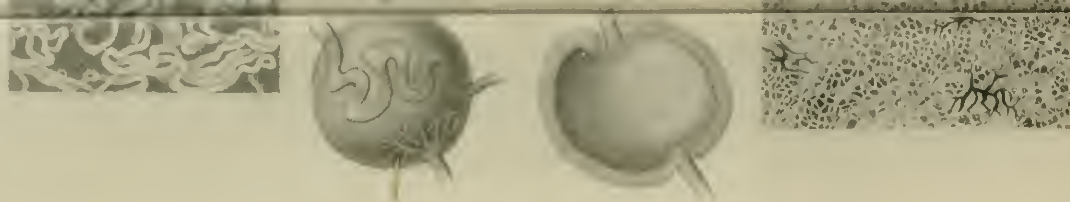


Fig. 5.

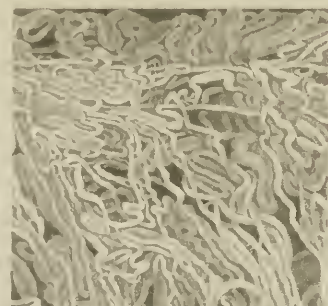


Fig. 13

Fig. 14.

Fig. 15.

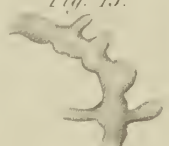
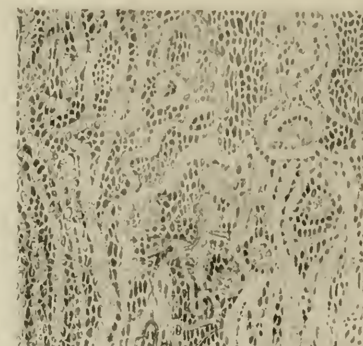


Fig. 6



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The tubuli in the cortical part of the kidney also terminate in the corpora Malpighiana,—a fact which Shumslansky was the first to describe; but of which Mr. Bowman has given a more accurate account. The relations of the tubuli with the corpora Malpighiana will presently come under consideration.

Of the tubuli on the surface of the kidney.—The surface of the organ exhibits a more regular arrangement of the tubuli than is perceptible in the interior. There is a general disposition to form masses, or bundles, the component tubuli of which often appear to be in absolute contact. A connection is also established between the principal masses by the prolongation of one or more tubuli. The spaces arising from these intersections are tolerably well defined, though their dimensions are not uniform. A kidney, therefore, of which the tubuli have been successfully injected, will present, with the intervening depressions, a lobular external appearance, not unlike what is visible to the naked eye even in the uninjected specimen. Loops, convolutions, and dilatations, freely intercommunicating, characterize the tubuli of the surface. A small branch of a tube will, in one place, enter at right angles the convolutions of its neighbour; in another, a tube will be found to divide and subdivide, and finally re-unite, either in one trunk or in two, which take opposite courses, and communicate with separate tubuli. Here, a tube will suddenly swell into a convoluted mass; there, it will be subject to gradual dilatation, and as gradually regain its primitive dimensions. So numerous, indeed, are the variations in the distribution of the exterior tubuli, that the mode in which they are disposed can only be understood by referring to specimens, or to the engravings.—(Plate VIII. figs. 1, 2, 3, and 5.)

Of the manner in which the tubuli uriniferi terminate.—It has been stated already, that one way in which the tubuli uriniferi terminate, is by communicating with each other. Mr. Bowman, however, entertains a different opinion on this subject. He says, "Some distinguished anatomists have held that the tubes end in a plexiform manner, and have

stated themselves unequivocally to have seen this arrangement in injected specimens. I am induced to believe this opinion founded on deceptive appearances, either such as that above-mentioned, or that occasioned by the overlapping of the injected tubes. Others have considered the tubes to terminate in free blind extremities, unconnected with the Malpighian bodies."* As will afterwards be seen, the true cause of Mr. Bowman's disbelief of the opinion first stated, will be found in the fact of the probable incompleteness of his own injections.

A second mode in which the tubuli terminate, is in the corpora Malpighiana. Shumslansky first advanced this view, and Mr. Bowman has pointed out what he considers to be the true relations, from his examination of injected specimens. The ground on which I rest my impression that a communication exists between the Malpighian corpuscles and the tubuli, is that of having succeeded in distending the capsules of the corpora from the tubuli without any extravasation into the vascular tissues. It is singular that Mr. Bowman should not only deny the possibility of injecting the capsules of the corpora Malpighiana from the tubuli, but actually head a section of his paper, "*By the tubes the corpora Malpighiana cannot be injected.*" "Many anatomists," he states, "have taken extreme pains to inject the tubes from the pelvis of the kidney by means of the air-pump; but never has a single Malpighian body been thus filled. This, as it has been said, is a conclusive proof that the Malpighian bodies are not placed at the extremities of the tubes." Having thus assumed the impossibility of injecting the corpora Malpighiana from the tubuli, Mr. Bowman proceeds to demonstrate at some length that this "is a necessary effect of the anatomical disposition of parts." It is not my intention to criticize the grounds assigned by Mr. Bowman to account for the impossibility of injection, its possibility being abundantly manifest in many of my own specimens, in which those bodies are in this way distended; but the circum-

* Philosophical Transactions, Part I, 1842.

stances will excuse the observation, that while in scientific investigations we ought never to take for granted what has not been proved, it is equally incumbent on us not to deny the possibility of anything, merely because we may have been unable to arrive at its demonstration.

Although there is no doubt that the uriniferous tubuli have communication with the corpora Malpighiana, the precise nature of the communication has, it appears to me, not yet been satisfactorily stated. The view adopted by Mr. Bowman is, that the tubuli have an expanded origin, similar to that of the urethra in its origin from the bladder; that this expansion is composed of the basement membrane of the tube, and encloses in it the rounded tufts of capillary vessels, usually designated the corpora Malpighiana. By this mode of arrangement, the capillary vessels are in the cavity of the excretory tube, in direct contact with the urine, and unprotected by epithelium, mucus, or any kind of membrane.

The true relation of the tubuli to the corpora Malpighiana would seem to be as follows:—

1st. The capsule of the corpus Malpighianum, instead of being, as supposed, an expansion of the tubule, is a distinct globular investment, enveloping both the tubule and the tuft of vessels.

2nd. This globular investment is neither continuous with the tubule, nor with the blood-vessels, but is expanded over them.

3rd. Into one part of the capsule the artery enters, while the other receives the tubule.

4th. The artery divides and subdivides, so as to form a globular mass of capillaries in the interior of the capsule from which the efferent vessel emerges.

5th. The tubule, after penetrating the capsule, becomes tortuous, and twists into a coil, and after being in contact with the ramifications of the corpus, it emerges from the capsule.*—(See Plate VII. figs. 1, 2, and 3; and Plate VIII. figs. 9, 10, 11, 12, and 13.)

* Since writing the above observations, I have read, in the Medical Times,

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* Philosophical Transactions, Part 1, 1842.

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Of the Arteries of the Kidney.

The principal mode of termination of the renal arteries is in the corpora Malpighiana, although I am not prepared to deny that *some* of the branches may form a capillary network without entering the corpus. The structure and relations of the corpora Malpighiana are deserving of the most attentive consideration.

The corpora Malpighiana.—From the time of their discoverer to the present day, these bodies appear to have been objects of careful examination to various anatomists, among whom, notwithstanding, serious difference of opinion prevailed as to their structure and functions. Those modern investigators, however, who have submitted successful injections of the corpora Malpighiana to inspection by the microscope, seem to agree that they consist of plexuses formed by ramifications from the arterial branches. Müller, who is of this opinion, describes them as lying "in vesicular cavities of the cellular tissue between the tubuli uriniferi." Huschke also, after delineating the Malpighian body in the kidney of the salamander, characterizes it as made up of the convolutions of a single blood-vessel. Berres has contributed very beautiful drawings of the injected corpuscles in the human subject, and demonstrated that they consist of the divisions and subdivisions of a small artery, that their form is usually circular, and that small vessels are given off from their circumference.

an extract from a paper on this subject by Dr. Gerlach, of Mayence. He states that he has also succeeded in injecting the tubuli uriniferi from the ureter, and the Malpighian capsules at the same time. He states, however, "that the capsules do not form the extremities of the uriniferous tubes, as Mr. Bowman supposes, but constitute only diverticula, which communicate by a small neck with the angle formed by the uriniferous tubes, winding through the cortical part of the kidneys." Another important point noticed by Dr. Gerlach is, that he found the Malpighian bodies (the tufts) in the capsules covered with a layer of cells, which are in continuation with the cellules lining the internal surface of the capsules in a manner analogous to that in which the peritoneum is reflected on the intestines from the internal surface of the abdomen. In frogs, this membrane lining the capsule is covered with ciliæ.

The corpora Malpighiana are only to be found in the cortical portion of the kidney, where, though they may seem at first view to be promiscuously distributed to all parts alike, yet a closer inspection will discover that they are ranged more or less in rows radiating from the centre towards the surface of the organ, which rows correspond with the interspaces of the columns of tubuli in the central part.

Of the structure of the corpora Malpighiana.—These bodies are composed of two distinct elements,—a plexus of blood-vessels and a membranous capsule, which completely surrounds and envelops the plexus. Some of the most marked and frequently-occurring features of the disease treated of in the second part of these researches, will be found to arise from a morbid condition of these two elements of the corpora.

Of the capsules.—If a section be made of a healthy uninjected kidney, the naked eye is able to detect the presence, over the whole surface, of numerous globular vesicles, whose colour is a shade deeper than the surrounding parts. Several of these vesicles will be found to have been partially dislodged, from the substance of the organ, in making the section, and to project from its surface, while corresponding cavities will indicate where others have been dislodged during the same operation. The round bodies when viewed through the microscope, are discovered to consist of a thin transparent membrane enclosing convolutions of blood-vessels. This membrane is disposed in a spherical arrangement, and gives to the corpus Malpighianum its globular form. These bodies become flattened by a gentle compression, but resume their spheroidal figure as soon as the pressure is removed. The membrane just mentioned may be appropriately termed the capsule of the corpus Malpighianum. It is thin and transparent, nor can the microscope detect in it either fibres or cells. To its internal surface numerous fine granules are attached, and from one part of its circumference there frequently extends a funnel-shaped prolongation, which is in fact the point from whence the uriniferous tubule emerges. The mode of con-

nection between the two has been already treated of. By lacerating this capule it can be readily separated from the vessels it contains, which are attached to its surface only at one point, being elsewhere surrounded by a small quantity of fluid. The external surface of the capsule itself is also but slightly attached to the parenchyma of the organ, from which it may be detached with the greatest ease.

The contents of the capsule consist of convolutions of vessels closely aggregated together, and apparently attached to a central vessel from which they radiate. Towards their circumference the convolutions present dilatations, the greater number of which do not appear to be continuous with any other vessels. The exact mode in which the blood-vessels of the Malpighian body are disposed, can only be thoroughly understood by a careful examination of properly-prepared specimens. It will be seen that the small artery of the corpus has various modes of distribution. In some instances, immediately on entering the capsule it divides into two or three branches, these again subdivide and form the convoluted plexus, which plexus having been again collected into a single trunk, issues from the capsule close to the point at which the artery entered it, and then divides once more to form the capillaries of the organ. From the minuteness of the healthy corpus, it is impossible from that to ascertain with precision the manner in which the emerging vessel of the corpus takes its rise from the rete; but from an examination of the Malpighian bodies when morbidly enlarged, it would appear that it springs from the convoluted vessels by radicles of much smaller dimension than the convolutions themselves.—(Plate IX. figs. 1 and 2.) In some instances the rete seems formed by a single branch of a single vessel in which the artery terminates. Though as a general rule it is otherwise, I have occasionally been enabled to obtain a distinct view of the capillaries arising directly from the convolutions of the corpus. The single trunk which emerges from the corpus sometimes unites with another proceeding from an arterial branch which is entirely unconnected with the corpora. In

Fig. 1.

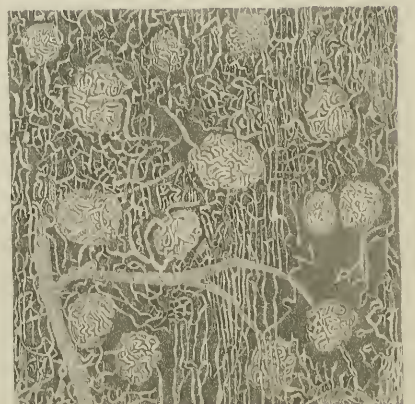


Fig. 2.

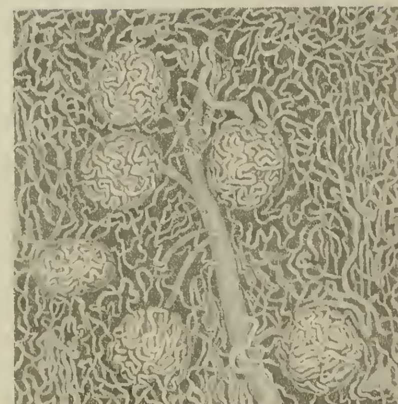


Fig. 3.

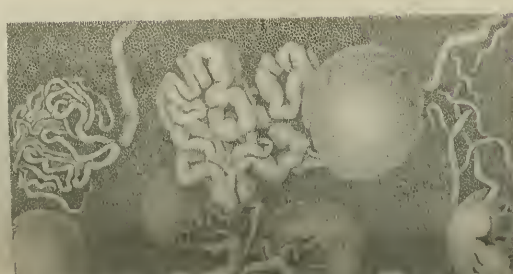
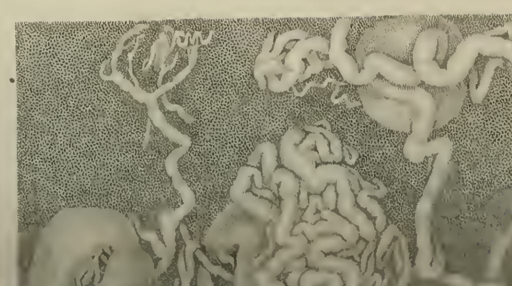


Fig. 4.



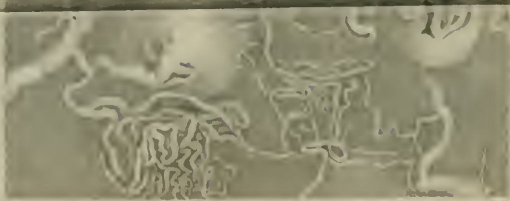


Fig. 5.

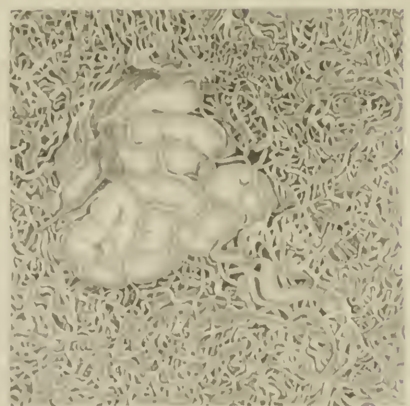


Fig. 6.

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this case, the combined trunk immediately divides again into capillaries. There occur instances where the efferent vessel emerges from a part of the capsule distant from that at which the efferent vessel entered. The meshes of the capillaries are elongated in a direction from the centre to the surface of the organ: and it has been already noted that the Malpighian bodies are disposed in a more or less regular and lineal order, the tendency of the lines being from the tubular portion of the organ towards its surface. The spaces between these rows contain the capillary ramifications, and correspond with the columns of tubuli in the tubular division, in the like manner as the rows of corpora do with the interspaces of the columns.—(Plate VIII. figs. 4 and 6.) The arteries in the tubular region of the kidney present the peculiarity of following a straight course, and are arranged in bundles of the shape of elongated cones whose bases are continuous with the cortical portion, and their apices directed towards the mammillary processes.

The Veins of the Kidney.

Like the arteries of the kidney, the veins are also remarkable for their large dimensions. The trunks have their commencement on the surface of the organ, in small stellated branches, which, passing through the cortex, are there considerably increased in volume by the junction of the numerous ramifications at the bases of the pyramidal masses. The veins situated in the tubular region having entered them, they, by their union, form the larger vessels which surround the pelvis, and terminate at length in the renal vein. The peculiar disposition of the veins is the efficient cause of that lobulated appearance of the surface of the kidney which has been described by various anatomists, and, among others, by Ferrein.*

It is not a little remarkable, however, that entertaining these views, Ferrein should have caused the kidney to be engraved as though it were composed of numerous pyramids, having their apices in the tubular region, and their bases re-

* Mémoires de l'Académie Royale des Sciences, 1791, pp. 501, 502.

presented by the angular intersections of the surface of the organ. In the uninjected section these pyramids are figured as if throughout they remained perfectly distinct.

The researches which I have conducted, afford abundant evidence that the substance of the kidney is not divided into pyramids, and that the appearances delineated by M. Ferrein as existing not merely on the surface but in the substance of the organ, are caused by the local arrangement of the blood-vessels. The peculiar lobular phase of the exterior surface is, in fact, the natural result of the mode in which the small veins are disposed. Instead, therefore, of the interspaces "being in some places marked by the ramifications of a vein," it will be found that it is the venal ramifications which really produce all the singular angular intersections characteristic of the superficies; and that, whenever there is a deficiency of blood in the veins, the phenomena cease to be perceptible.

If a section of the surface of the kidney, with the veins and capillaries well distended, be microscopically examined, the veins will appear so disposed as to form the boundaries of various interspaces whose configuration is mostly either pentangular or hexagonal.

These spaces impart the lobulated appearance to the surface of the organ, and within them the capillaries ramify, (Plate X. fig. 1,) forming a very intricate plexus, and giving rise to the white hue generally observable. The capillaries are continuous with the circumscribing veins; and, as they are usually empty, or contain but a very trifling quantity of blood, they appear by contrast paler than the latter. The degree to which the veins are distended in different specimens, and even in parts of the same specimen, being extremely variable, a corresponding diversity in the apparent forms of the lobuli, or interspaces, is the natural result. In some parts, for instance, the veins are completely charged, and the terminal lines of the spaces consequently perfect (Plate X. fig. 1. portion not magnified); in others, the veins being only partially filled, there is less distinctness in the lobular outline. The varying extent, therefore, to which the blood-vessels may be distend-

Fig. 1.

Fig. 2

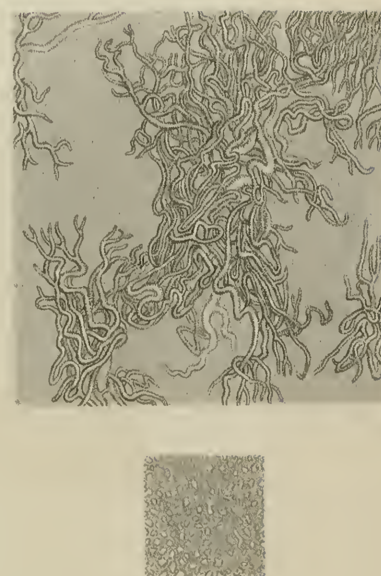


Fig. 3.

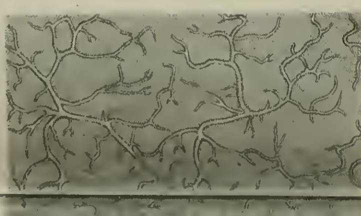


Fig. 4.

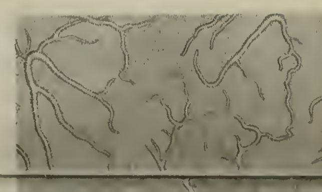
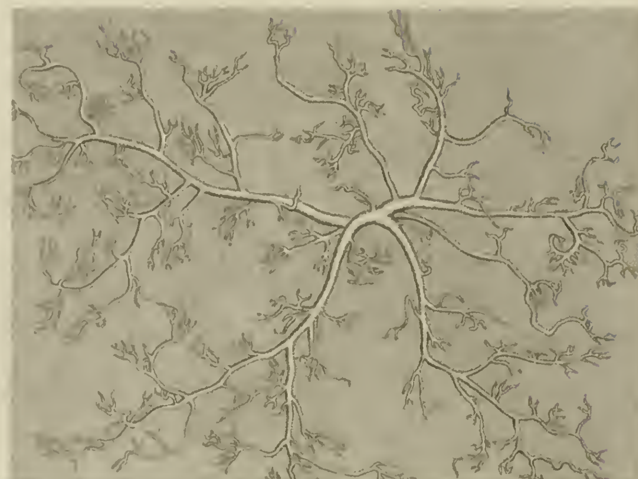


Fig 5



ed, produces as marked a difference in the appearance of the surface of the kidney, as arises in the liver from an analogous cause.* It will be observed, that at some points the lines thicken, and this occurs wherever two or more veins meet at one angle V; the phenomena resulting from the junction of the veins at the spot. The thickened portion is, in fact, the commencement of the trunk of the vein; and the enlargement of this small venous radicle produces the large stellated veins so commonly met with on the surface of diseased kidneys.

The venous branches which arise on the surface of the kidney, in the way just described, follow a straight course through the cortex, where they receive numerous tributary venous canals, and continue to increase in size till they form at last the large veins around the ureter. The distribution of the veins in the pyramidal masses of the kidney offers an interesting subject of contemplation to the anatomical inquirer. The capillaries surrounding the base of each pyramid unite into straight vessels, and these, again, are collected into bundles between the columns of tubuli: their direction being towards the mammillary process. In their progress they frequently divide and re-unite. At the apex of the mammillary process these vessels form a considerable plexus, the ramifications of which are often larger than the direct vessels which enter them, presenting occasionally, also, dilated receptacles. In their approach to this plexus, the straight vessels establish frequent intercommunications by means of large transverse branches; and, at intervals, between the base and apex of the pyramid, many of them form loops, and return on their course.

Continuous with the plexus there are besides vessels which take a retrograde course towards the base of the pyramid, where some of them enter the venous trunks, whilst others appear like prolongations of the venous radicles. These veins of the medullary region of the kidney are frequently

* Vide Mr. Kiernan's Researches on the Liver. Philosophical Transactions, 1833.

found to be highly charged with blood. On reviewing the mode of arrangement of the venous branches, which has just been described, it will be evident that, on the external and internal surface of the organ, they constitute receptacles for blood of no inconsiderable capacity. It would seem but reasonable, therefore, to infer that, under certain conditions of the circulation in the kidney, the venous plexuses on the surface of the organ, together with those in its pyramidal masses, ought to be regarded as receptacles for the venous blood, precisely in the same way as, under like conditions, the Malpighian corpora are for the arterial.

Pathological Observations.

Previous to stating the result of my own investigations into the pathology of Bright's disease, I am desirous of making a few observations on the recent researches of which it has been the subject, more especially in this country.

There appears to be no doubt that the true cause of this disease is the circulation in the blood of the organ, of an unnaturally large quantity of carbonized and azotized elements. The condition may exist in two widely different cases.

1st.—Among the richer classes of this country, where the mass of the blood may become supercarbonized in connection with a full habit of body, food too nutritious, and deficiency of exercise.

2nd.—Among the working classes, from want of sufficient oxygen in the air of their close and ill-ventilated abodes, to decarbonize the blood in the lungs, and the constant use of fermented and spirituous liquors.

It has been proved that the ultimate effect of this supercarbonized state of the blood, is the deposition, in the kidney, of adipose matter. In the words of Dr. Johnson, " Bright's disease may be described as primarily and essentially an ex-

aggeration of the fat which exists naturally in small quantities in the epithelial cells of the healthy gland."

Many observers in this and other countries have noticed the presence of an unusual quantity of fat in the kidney as characteristic of Bright's disease; and among my own notes there are drawings, made four or five years ago, of the oily globules found in the tubuli. But these and all other researches on this point must now be considered as supplementary to, and confirmatory of, the view advanced by Dr. Johnson in his elaborate and comprehensive paper, read during the present session, and which appears to me to be the only account which exhibits the disease in its true relations.

In the observations which will presently be submitted, I have divided the disease into three stages, each of which is founded on certain pathological conditions of the organ; but antecedent to the development of the phenomena peculiar to any of these changes, there are grounds for believing that the organ is for some time in a state of congestion.

Dr. George Robinson,* in his very interesting and valuable contribution towards a knowledge of this disease, has clearly shown that a congested state of the blood-vessels of the kidney gives rise to albuminous urine; and he concurs with Dr. Bright, and many other observers, in thinking that this condition precedes the other stages of the disease. From this conclusion Dr. Johnson differs, for he states, "There is no reason for believing in the existence of any congestive stage as necessarily preceding any morbid change." Now, considering that in this disease the blood is highly charged with carbonized principles, and, consequently, that in its circulation through the kidney, that organ must be called upon to throw off a larger quantity of carbonaceous matter than the natural secretion would contain, an amount of irritation will be excited which must be followed by nervous depression and ultimate congestion of the entire organ. This general view, combined with the results of my investigations into the early

* Med.-Chir. Trans. vol. xxvi.

stages of the disease, induces me to agree with Dr. Bright, and others, that the congestive condition of the blood-vessels of the organ does precede, and that necessarily, the deposition of fat, the enlargement of the organ itself, or of its uriniferous tubes, or of any other of its vessels.

The cause of the presence of albumen in the urine is acknowledged to be an obstructed condition of the blood-vessels of the organ. Dr. Johnson considers the obstruction to arise from a deposition of fat in the tubuli uriniferi; but there can be no doubt that albuminous urine often exists without any such deposition.

The first stage of the disease.—In this stage, the kidney is enlarged, and innumerable black points are visible, which are the corpora Malpighiana dilated, and their vessels distended with blood, seen through the capsule. The white spots, which derive their appearance from the collection of fatty matter, begin to be perceptible.

The peculiar features of this stage consist of an enlargement of the arteries entering the corpora Malpighiana; the dilatation of the vessels of the tuft, the capillaries and the veins; an increase in the size of the capsule of the corpus and of the tubuli, and a large addition to the quantity of the parenchyma of the organ.

The condition of the arteries is visibly changed, even at this early period: the artery entering the corpus being actually twice or thrice its natural size, which is the case also with the Malpighian tuft and the capillary vessels which spring from the tuft. An injection, in this stage, cannot very easily be made to pass through the tuft and fill the capsule of the corpus,—a circumstance which almost always attends injection in the later stages of the disease.—(Plate IX. fig. 2.)

The capillaries and veins are greatly enlarged, giving to the surface of the organ the resemblance of network.—(Plate X. figs. 2 and 3.) This is the commencement of the stellated condition, which is so marked a characteristic of the next stage of the complaint.

The tubuli in this stage are also much increased in their dimensions; but the fat which is found in them is soft and white.

The second stage of the disease.—The organ in this stage is very greatly increased in size, its surface is smooth, and presents numerous white spots; the capsule is but slightly adherent to the surface, and the tissue of the organ is flabby.

The structural changes exhibited during this stage are the following:—

1st.—The artery of the corpus Malpighianum becomes so greatly enlarged, that frequently it equals the dimensions of the tube itself, and is eight or ten times its natural size. It is tortuous and dilated, and sometimes, previous to entering the capsule of the corpus, presents analogous swellings to those of varicose veins. The primary branches of it, in forming the tuft, are also distended to ten or fifteen times their natural size, and are not unfrequently discovered external to the capsule of the corpus, as though thrust out by some internal force. The vessels forming the tuft are likewise enormously enlarged, and very often the minutest branches are fully as large as the main artery of the corpus in a healthy state.

Occasionally the tuft is broken up, and instead of forming a compact mass, exhibits its individual branches separated from each other. At other times the branches of the tuft are actually larger than the primitive artery of the corpus.—(Plate IX. figs. 3 and 4, and Plate XI. fig. 2.) Under these circumstances it is singular that Mr. Bowman should have made the following remarks:—"Though I have examined, with great care, many kidneys at this stage of the complaint, I have never seen, in any one instance, a clearly dilated condition of the Malpighian tuft of vessels." He adds, "On the contrary, my friend Mr. Busk, an excellent observer, has specimens which undoubtedly prove these tufts not to be dilated in the present stage; and I possess injected specimens showing them at all

stages, but never above their natural size." It is very possible that the peculiar injection used by Mr. Bowman may account for the fact which he mentions, and this conjecture is rendered extremely probable, as in the latter stages of the disease the Malpighian tuft becomes pressed upon by the adipose accumulation within, and, after undergoing compression, will permit the fluid used in the process of double injection to pass through rather than yield and distend. There are instances again in which the tufts are not enlarged, but appear healthy even in organs otherwise extensively diseased: but it is important to add, that these tufts, both in the second and third stages, when but slightly enlarged, or even not enlarged at all, will offer free passage to the injection, on the most gentle pressure, without even distending the whole of their vessels, and thus indicate their diseased condition.

An enlargement of the renal arteries and dilatation of their branches are also observable in this stage of the disorder.

The capsule of the corpus, too, is in this stage very greatly increased in size, and during the process of injection becomes frequently filled with the injection thrown into the arterial system. Although thus enlarged, it does not become ovoid, but presents slight bulgings in several parts.—(Plate IX. figs. 3 and 4.)

The tubuli differ considerably from their healthy condition, being enlarged to two or three times their natural size, and aggregated together in masses, so as to lie in contact with each other, and form definite, roundish bodies: they are also extremely convoluted with numerous dilatations; frequently they are varicose.—(Plate IX. figs. 3 and 4.) At other times they present distinct aneurismal sacs, which bulge out from one part of the wall of the tube, to which they are attached by a small neck or pedicle.—(Plate VIII. figs. 14 and 15.) Occasionally, some of the vessels of a convolution are smaller than the others, and their size nearly natural. The tubuli in the masses are so closely packed, that the blood-vessels are evidently compressed, and rendered incapable of admitting an injection. At times a tube even

at some distance from the corpus, becomes very convoluted, and knotted into a mass.

Parenchyma.—In cases where the kidney is much enlarged, the parenchymatous cells will be found not merely increased in size, but adipose depositions will be visible throughout them.

The third stage of the disease.—The kidneys are smaller than their natural size; hard, white granules are prominent on their surface, which is more or less lobulated; the capsule is adherent; vesicles of large size are frequently everywhere interspersed; and numbers of smaller ones stud the whole surface. On making a section, the organ is found to be deprived of blood; the cortical part contracted, the blood-vessels large, and their walls thick.

Arteries.—The arteries are in a more contracted condition than that described in the second stage; and the Malpighian tuft is so often changed from its natural state, that the greater part of its vessels are not capable of being injected.

The capsule of the corpus has assumed a more contracted appearance.

The arteries in this stage are so difficult to inject, that some anatomists have denied the possibility of the operation. The difficulty has its origin in the great pressure, which is exerted on the whole of the arterial system, by the contraction and hardening of the organ.

Veins.—The veins in this stage present on the surface of the organ the well-known stellated aspect which arises from the gradual pressure exerted on the trunks, and the contraction of the organ. These changes are well delineated in the engraving.—(Plate X. figs. 4 and 5.)

Tubuli.—The tubuli are larger than in the preceding stage, and are gathered into rounded masses, which form the granules on the surface of the organ. The latter are of a white hue, and are most commonly fully distended with fatty depositions; though not unfrequently they appear like dark spots: the tubuli in that case being full of blood. A rounded

appearance is generally characteristic of the granules, in each of which the component tubule forms innumerable convolutions. It is extremely difficult to inject the tubuli from the ureter; indeed it is very rarely that it is possible to distend them from this source; nor is it an easy matter to fill them from the artery, though, as will be seen in the drawings, my efforts have not been without success. The tubuli are filled will oily cells, granular matter, particles of various sizes, and blood globules. Plate XI. figs. 1, 3, 4 and 5, illustrate the condition of the tubuli in the third stage.

Parenchyma.—The parenchyma is hard, and is composed of elongated stellated cells, from the angles of which fine threads proceed, and communicate with each other.

The nature and causes of the disease which has been under consideration, having now been tolerably well ascertained, professional duty demands the further very interesting enquiry, whether means can be adopted by which the development of the disease may be prevented.

Among all classes the use of a less stimulating diet,—whether the stimulus arises from the excess of nutritious solids, as in the upper classes,—or from improper food and the abuse of intoxicating beverages, as in the working classes,—is one of the remedies whose obviousness renders all reasoning superfluous.

Vigorous and regular exercise in pure air, and daily ablutions of the entire body, as promoting digestion and secretion, increasing the respiratory efforts to decarbonize the blood by the lungs, and the transpiratory excretions of the skin, will also be most valuable auxiliaries.

But among numerous bodies of the population, and especially among the labouring classes, other causes demanding other remedies would appear to be in operation. Dwellings badly built and drained, situated in close, confined and densely-populated localities, deprived of light, and constantly containing an impure air, exercise a very deteriorating influence on the physical condition of a large proportion of the

Fig. 1

Fig 2.

Fig 3.

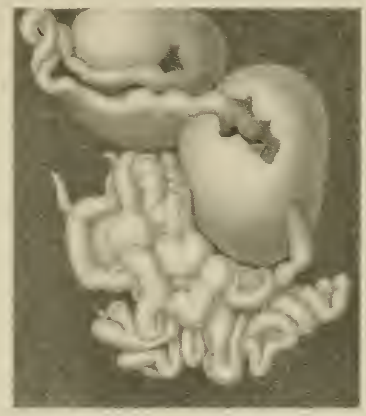


Fig 4

Fig. 5.

industrious classes, and they are especially active in the production of the disease, which has formed the subject of this paper.

EXPLANATION OF THE PLATES.

Plate VII.

Figs. 1 and 2.—Portions of the cortical and pyramidal divisions of the kidney, the tubuli being distended from the ureter to the surface of the organ. Fig. 1, represents the periphery of the pyramidal mass. Fig. 2, the central part.

Figs. 3, 4, and 5.—Portions of the cortical part of the kidney, showing the arrangement of the tubuli.

Figs. 6, 7, 8, 9, 10, and 11.—Diagrams illustrating various modes in which the tubuli are disposed.

Plate VIII.

Figs. 1, 2, and 3.—Portions of the surface of the kidney, showing the mode in which the tubuli are arranged.

Fig. 4.—Capillaries ramifying over the tubuli on the surface of the kidney.

Fig. 5.—Tubuli passing from the cortical part of the kidney to the surface.

Fig. 6.—Capillaries ramifying over the tubuli in the cortical portion of the kidney.

Figs. 7, 8, and 9.—Diagrams of the tubuli.

Figs. 10, 11, 12, and 13.—Diagrams of the corpora Malpighiana.

Figs. 14 and 15. — Varicose conditions of diseased tubuli uriniferi.

Plate IX.

Fig. 1.—The vascular plexus of the Malpighian body in a healthy state.

Fig. 2.—The vascular plexus enlarged, and its component vessels dilated.

Figs. 3 and 4.—The vascular plexus still further enlarged and diseased, the capsule much dilated, and the tubuli thrown into convoluted masses.

Fig. 5.—The capillary vessels on the surface of a kidney, in the early granulated state; they are extremely numerous and much enlarged, as is seen by a comparison with fig. 4, Plate VIII.

Fig. 6.—The capillary vessels on the surface of the kidney, in a later state of granulation, when there is great difficulty in injecting any of the blood-vessels.

Plate X.

Fig. 1.—The veins on the surface of a healthy kidney.

Figs. 2, 3, and 4.—The veins in the earlier stages of Bright's disease.

Fig. 5.—The stellated condition of vein in the advanced stages of the disease.

Plate XI.

Fig. 1.—Two granulations on the surface of the kidney in an advanced stage of Bright's disease.

Fig. 2.—Diseased blood-vessels in the interior of the Malpighian capsule.

Fig. 3.—Tortuous and varicose tubuli uriniferi.

Fig. 4.—A tube much enlarged, and forming a granulation in its passage through the cortical part of the organ.

Fig. 5.—A tube very much dilated.

In conducting the researches from which all of the above engravings were taken, Powell's $\frac{1}{2}$-inch object glass was used, the magnifying power of which is about 80 diameters.

ON THE RELATION

BETWEEN THE

CONSTITUENTS OF THE FOOD,

AND THE

SYSTEMS OF ANIMALS.

By ROBERT DUNDAS THOMSON, M.D.,

LECTURER ON PRACTICAL CHEMISTRY IN THE UNIVERSITY OF GLASGOW.

Communicated by Sir B. C. BRODIE, Bart.

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The idea which is now entertained by physiologists, that the muscular part of the animal frame is derived from the albuminous constituent of the food, was clearly pointed out by Beccaria in the year 1742 (Histoire de l'Academie de Bologne, Collect. Acad. xiv. 1): he demonstrated that the flour of wheat contained two characteristic ingredients, which, on distillation or digestion, afford products totally dissimilar to each other. One of these, which he termed the starchy part, resembles in its constitution, vegetable matters, and supplies analogous products. Vegetables, he says, may be recognized by their fermenting and yielding acids, without exhibiting symptoms of putrefaction. The glutinous part of flour, on the contrary, resembles animal matter, the distinguishing feature of which is its tendency to putrefaction and conversion into a urinous (ammoniacal) liquid. "So strong," he adds, "is the resemblance of gluten to animal matter, that if we were not aware of its being extracted from wheat, we should not fail to mistake it for a product of the animal world." To convince ourselves of his thorough identification of gluten and animal muscle, it is only necessary to quote his query, "Is it not true that we are composed of the same substances which serve as our nourishment?" The same doctrine has been taught

and practised in this country for upwards of twenty years by Dr. Prout, without any knowledge of Beccaria's views, and is now almost universally received by European physiologists, although the true authors may not always have been recognized.

With reference to the source of the fatty and oily matters which enter into the constitution of the animal system, much discussion, it is well known, has recently been carried on by Liebig and Boussingault; the former considering that they may be derived both from oil and starch, while the latter at one time was inclined to attribute the origin of fat in animals entirely to the oil contained in the food. An opportunity having lately occurred to the author, of throwing some light upon this subject, by experiments on a large scale,* the results have been condensed in the following Table, and seem to show that the oil contained in the food is by no means sufficient in amount to afford a source for animal fat.

Table I.—Table exhibiting the Amount of Oil and Wax in the Food, Dung, and of the Butter, in two Cows.

Food.	Wax and oil in food.	Butter.	Wax in dung.	Excess of wax in dung, and of butter.	Excess of wax and oil in food.
	lbs.	lbs.	lbs.	lbs.	lbs.
1.—Grass	57·36	16·71	6·30	. .	34·35
2.—Entire barley and grass .	39·85	10·53	5·37	. .	23·95
3.—Entire malt and grass .	34·70	11·52	4·97	. .	18·41
4.—Crushed barley, grass & hay	32·16	19·10	13·76	0·70	. .
5.—Crushed malt and hay .	22·25	17·68	12·97	8·40	. .
6.—Barley, molasses and hay .	14·46	11·88	8·85	6·27	. .
7.—Crushed barley and hay .	7·68	5·22	4·27	1·81	. .
8.—Barley, linseed and hay .	16·75	11·98	8·61	3·84	. .
9.—Bean meal and hay . .	7·64	6·40	4·04	2·80	. .
	100·94	72·26	52·50	23·82	

* See Report presented to the Houses of Parliament, on Feeding Cattle with Malt, 1846; and "Experimental Researches on the Food of Animals, &c." 8vo. Longman, 1846.

For the details of these experiments, see Report presented to Government on the Feeding of Cattle. For Experiment 1, see page 53 of "Experimental Researches;" 2, ibid. p. 85; 3, ibid. p. 91; 4, ibid. 98; 5, ibid. 100; 6, ibid. 102; 7, ibid. 126; 8, ibid. 128; 9, ibid. 130. The manner of conducting the experiments from which these numbers have been deduced, was as follows:—

The whole of the food was accurately weighed, and the amount of wax and oil contained in it determined by extracting from a limited portion of it the quantity of matter soluble in ether; with grass it was found that 2,000 grains of grass when dried at 212 became 500 grains. This when digested in ether yielded 42·3 grains of a green waxy matter, which gives the per centage of wax in grass 2·01. Hay in the same manner, when dried and exhausted by ether, gave 2·00 per cent. of wax. All the other substances were treated in the same manner. The per centage of wax and oil contained in each was as follows:—

Wax	per cent.	Oil	per cent.
Rye grass . .	2·01	Barley	2·18
Rye Grass Hay .	2·00	Malt	1·37
Moist Grass dung .	0·312	Linseed . . .	4·00
Moist Hay dung .	0·600	Bean Meal . . .	2·01
Dry Grass ditto .	2·67		
Dry Hay ditto .	3·82		

The whole of the butter was extracted from the milk by the common process of churning. The Table therefore gives the total amount of wax in the food for each experiment; the wax in the dung, which was never found to contain oil; and the butter of the milk. An example may be sufficient to explain the whole process. Two cows in 14 days consumed 1,427 lbs. each of grass = 2,854 lbs. in all. As rye grass by experiment was found to contain 2·01 per cent. of wax, the total amount of wax in the grass consumed will be 57·36 lbs. The two cows gave, one 343 lbs. and the other 305 lbs. of milk; the total being 648 lbs. One cow gave 180 oz. ($11\frac{1}{4}$ lbs.) of butter, and the other 130 oz. ($8\frac{1}{8}$ lbs.) of butter.—Total = 19 lbs. 6 oz. or 310 oz. But as butter yielded by experiment, casein 0·94,

water 12·79, oil 86·27, it is necessary to deduct the impurity, which reduces the total oil to 16·71 lbs., as in the Table. The dung was found to contain ·312 per cent. of wax; the total dung voided by the animals, being weighed, amounted in 14 days to 2,049½ lbs., and would contain 6·30 lbs. of wax. Then the last column is obtained by deducting the wax in dung and butter, from the wax in the food, 16·71 + 6·30 = 23·01: then, 57·36 — 23·01 = 34·35 = Excess of wax in the food. (See "Experimental Researches on the Food of Animals," p. 67.)

From this Table it appears, that when grass was employed as food, there was much more wax in the food, than wax excreted and butter in the milk; but as soon as hay was substituted for the grass, the butter and the wax in the dung together exceeded the amount of oil in the grain and wax in the hay. These facts appear to demonstrate that the butter is not derived from the oil or wax; the latter in hay and grass being a green substance, bearing no resemblance to an oil. We see in the 6 latter experiments, that while the food contained about 101 lbs. of wax and oil, the dung contained 52½ lbs. of wax, or half of that contained in the food; the amount of wax and oil in the dung and butter exceeding that in the food by nearly 24 lbs., or about one-fourth part. As the experiments from which these numbers are deduced were made upon a large scale, during a period of 3½ months, with every attention to accuracy, we think it may be legitimately inferred that the oil of the food alone is not sufficient in amount to account for the production of oily matter in the cow.

That the systems of animals are capable of sustentation by a supply of fibrinous matter almost alone, is obvious from the history of the primitive inhabitants of the prairies of America. It is stated on good authority (Catlin) that there are 250,000 Indians who live almost exclusively on buffalo-flesh during the year. The fresh meat is cut in slices of half-an-inch in thickness across the grain, so as to have fat and lean in layers, and is hung up, exposed to the sun, and dried. Upon the food, which is pounded and eaten sometimes with marrow, the wild hordes of the West are not only nourished, but it is obvious

that the heat of their bodies is kept up; since they taste no vegetable food whatever. Fibrin is therefore, we infer, *calorifiant*,* or alone capable of producing animal heat. This conclusion we also deduce from the experiment in which a dog was fed for some weeks on the glutinous matter of flour (Magendie). And it may be further concluded that fibrinous or albuminous matter, when given alone, is partially converted into carbonic acid, and is removed from the system during the process of expiration. But it would appear from a consideration of the experiments which have been made on the nutrition of animals with pure fibrin, that an auxiliary in the production of animal heat is either indispensable or highly advantageous, since animals fed on fibrin alone invariably declined in health (Magendie); and the American Indians have a certain admixture of fat with their dry meat, and are in the habit likewise of using marrow with it. That the amount of calorifiant food in contradistinction to nutritive food, properly so called, as it has been well defined by Liebig, is out of all proportion greater than that required to supply the waste of the solid matter of the body, is obvious from the following Table, which represents the amount of the ultimate constituents and ash of the food of a stall-fed cow, consumed during the day.

Table II.

	Food.	Fæces.	Consumption.
	lbs.	lbs.	lbs.
Carbon .	11·90	5·10	6·80
Hydrogen	1·61	0·62	0·99
Nitrogen .	0·45	0·20	0·25
Oxygen .	10·74	4·12	6·62
Ash .	1·71	1·09	0·62
	26·41	11·13	15·28; or 14·66 less the ash.

* Liebig, it is well known, divides the functions of the food into nutritive and respiratory. The author has ventured to employ instead of the latter

The data from which this Table was constructed will be found at p. 65 of "Report," or p. 57 of "Experimental Researches on the Food of Animals." The ultimate composition of the grass and dung was determined, and the amount of the elements in each calculated as in the Table. The dung subtracted from the food gives the third column, indicating the matter taken up into the circulation of the animal.

The food in this case was grass (Lolium perenne, or rye grass). If we now calculate the amount of food which was destined for nutrition by the following formulæ, we find that it amounts only to 1·56 lbs. Albuminous matters contain about 53 per cent. of carbon, 7 of hydrogen, 16 nitrogen, and 24 oxygen: hence to obtain the carbon of the nutritive matter in the above Table, we have $\frac{\cdot 25 \times 53}{16} = 0{\cdot}828$ lb. carbon; for the hydrogen $\frac{\cdot 828 \times 7}{53} = \cdot 109$ lb. hydrogen; for the oxygen $\frac{\cdot 109 \times 24}{7} = 0{\cdot}373$ lb. oxygen. By multiplying the nitrogen by 6·25 we obtain the total amount of nutritive matter very nearly; or, as represented in a tabular form,—

Table III.

	Nutritive.	Calorifiant.
Carbon . .	0·828	5·972
Hydrogen .	0·109	0·881
Nitrogen . .	0·250	. .
Oxygen . .	0·373	6·247
	1·560	13·100

A true system of dieting would, therefore, require such tables for each condition of animals, in order that a comparison may be instituted between the wants of the system and

term the expression *calorifiant* or *heat producing*, so as to give a wider range, extending through the whole system to the function of the unazotized food, than the more local term of respiratory would appear to imply. According to this view, all food is destined for repairing the waste of the system, and for the production of animal heat.

the food. If this mode of viewing the question be correct, then the relation of the nutritive part of the food absorbed by the animal system in the preceding experiment is to the calorifiant portion as nearly 1 to $8\frac{1}{3}$. By comparing this fact then, which is independent of all hypotheses, with the different varieties of human food, it is probable that some light may be obtained in reference to the differences in the relative proportion of their constituents. Milk, for example, the food of the infant mammalia, contains one part of nutritive to two parts of calorifiant constituents, and in the growing state of an animal, the nutritive part of the food not only supplies the place of the metamorphosed solids, but an additional amount of it is required to increase the bulk of the individual; and as it has been already stated that animal heat is generated by the metamorphosis, or degradation of the fibrinous tissues, it is obvious that in the nourishment of infant life, there is a supply of heat from the casein vastly superior to that afforded by fibrin, to adult animals.

If we refer again to the food which is generally employed by the inhabitants of our own country, wheat and barley, we find by a mean of experiments detailed in a subsequent Table, that the average amount of albuminous matter present in them is 11 per cent., while the quantity of starch and sugar existing in these substances may vary from 70 to 80 per cent., thus affording the relation between the nutritive and calorifiant matter of 1 to 7, and upwards. Such food, it may be inferred, is fitted for the consumption of an animal which is not subjected to much exercise of the muscular system, and may be viewed as the limit of excess of the calorifiant over the nutritive constituents of food. As the demands upon the muscular part of the frame become more urgent, the proportion of the azotized or nutritive constituents should be increased, and this may be extended until we arrive at the point where the fibrinous matter is equal to the half of the calorifiant, which is probably, in a perfectly normal physiology, the greatest relative proportion of nutritive material admissible. The proportion of the nutritive to the

calorifiant constituents of food should therefore vary according as the animal is in a state of exercise or rest; and it is upon the proper consideration of such relations that the true laws of dieting depend. For calculations of this nature, tables exhibiting the amount of albuminous matters in the different articles of food, are indispensable, as they afford at a glance the required knowledge. The constituents of the flour used as human food are principally albuminous matter, calorifiant matter, water and salts, so that when we have determined the amount of albuminous substance in the dried condition of the flour, the remainder may be considered as calorifiant matter, without any sensible error: in the following Table the water has not been removed from the flour.

Table IV.

	Albuminous matter per cent.		Albuminous matter per cent.
Bean meal	25·36	East Lothian flour	9·74 to 11·55
Linseed	23·62	Hay	9·71
Scottish oatmeal	15·61	Malt	8·71
Semolina	12·81	East Indian rice	8·37
Canadian flour	11·62 to 12·81	Sago	3·33
Barley	11·31	South Sea arrow-root	3·21
Maize	10·93	Tapioca	3·13
Essex flour	10·55 to 12·50	Potatoes	2·23
		Wheat starch	2·18
		Swedish turnips	1·32*

This Table is the result of experiments made by the author. The nitrogen was accurately determined in the usual manner by means of lime and soda and precipitation, as ammonia by bichloride of platinum. To obtain the amount of albuminous matter, including under the term, albumen, fibrin, casein, and

* For other experiments, see Proceedings of Philosophical Society of Glasgow, vol. i. p. 164.

glutin, the per centage of nitrogen is multiplied by 6·25, the mean quantity of nitrogen in these bodies being 16 per cent. For example, beans were found by analysis to contain 4·057 per cent. of nitrogen. Now the albuminous matter in beans (albumen, fibrin, casein, and glutin) contains about 16 per cent. of nitrogen, and as $16 \times 6{\cdot}25 = 100$, it is obvious that $4{\cdot}057 \times 6{\cdot}25 = 25{\cdot}36$, the amount of albuminous matter in beans.

This Table represents the amount of albuminous matter contained in 100 parts of the various substances as they occur in commerce. As all of these substances contain from 5 to 14 per cent. of water, certain deductions are required to enable us to arrive at the true amount of calorifiant matter. In general, it may be stated that wheat flour, maize, barley, and beans, contain from 10 to 14 per cent. of water, while oatmeal contains six per cent., and tapioca, arrow-root, and sago, from 10 to 13 per cent. In order to arrive at the true amount of calorifiant matter contained in the above substances, we have only to deduct the amount of albuminous matter in the Table with the water and salts, which, upon an average, amount together to about 12 to 15 per cent.* Then by dividing the remainder, or calorifiant matter, by the amount of albuminous substances, we obtain the relation subsisting between the nutritive and calorifiant constituents. The exceptions to the rule are obviously potatoes, turnips, and such moist bodies. In this manner tables may be constructed illustrating the true practice of dieting.

* Potatoes and turnips afford a remarkable exception to this statement. Healthy Peruvian potatoes of 1845, grown at Glasgow, yielded 72 per cent. of water, while the common potato gave as much as 78½ per cent. Turnips were found to contain 84½ per cent. of water.

Table V.

	Approximate relation of nutritive to calorifiant matter.
Milk, food for a growing animal	1 to 2
Beans ,,	1 to $2\frac{1}{2}$
Peas, Linseed ,,	1 to 3
Scotch oatmeal ,,	1 to 5
Wheat flour, Maize, Barley, food for animals at rest	From 1 to 7 to 1 to 8
Potatoes	1 to 9
East Indian rice	1 to 10
Dry Swedish turnips	1 to 11
Arrow-root, Tapioca, Sago	1 to 26
Wheat starch	1 to 40

This Table is calculated as follows:—By the author's experiments, milk contains butter 3·7, sugar 4·35, casein 4·16, per cent. Hence, the calorifiant matter, (butter and sugar,) divided by the casein or nutritive matter, gives $8{\cdot}05 \div 4{\cdot}16 = 1{\cdot}93$, or very nearly in the relation of 1 to 2. Again, to obtain the relation of nutritive matter to calorifiant matter in beans, we have, according to the approximate rule previously given, to subtract the water and salts and albuminous matter from 100 parts; or, $12 + 25{\cdot}36 = 37{\cdot}36$ to be deducted from 100, leaves 62·63 for calorifiant matter. Then, $62{\cdot}63 \div 25{\cdot}36 = 2{\cdot}47$, or nearly in the relation of 1 nutritive to $2\frac{1}{2}$ calorifiant. In the case of turnips and potatoes, the quantities of water being much greater, as previously stated, the calculation is somewhat different, but suggests itself at once to the reader: all very moist substances are in a similar condition. The numbers in the Table have been adopted as approximate, and have not been rigidly determined by the previous rule, because the actual numbers obtained by experiment will differ somewhat in the fractional parts by each trial.

From this Table we are led to infer, that the food destined for an animal in a state of exercise should range between milk and wheat flour, varying in its degree of dilution with calorifiant matter, according to the nature and extent of the demands upon the system. Milk may therefore be employed with a certain amount of starchy matter, such as the class of flours, with probable advantage, as is illustrated in the milk and potatoe diet of the inhabitants of Ireland; and may also be imitated by a mixture of animal and farinaceous food; but the dilution should not exceed the prescribed limits. It is thus that we may explain the fact of beans, oats, oatmeal, and barleymeal, being used so extensively in the feeding of horses. These articles of food do not sufficiently answer alone; calorifiant matter in the form of hay should also be supplied. From this Table, likewise, we infer that as nature has provided milk for the support of the infant mammalia, the constitution of their food should always be formed on the same model. Hence we learn that milk, in some form or other, is the true food of children, and that the use of arrowroot, or any of the members of the starchy class, where the relation of the nutritive to calorifiant matter is as 1 to 26 instead of being as 1 to 2, by an animal placed in the circumstances of a human infant, is opposed to the principles unfolded by the preceding Table. In such Tables as No. IV. it is usual to append a second column, exhibiting the equivalent value of the different kinds of food, representing, for example, 100 parts of beans as equal in nutritive power to 1160 of starch. But if the views now explained are legitimate, we see that such a method of estimating nutritive power is not founded on scientific principles. In a correct plan of dieting, the proper equilibrium must be retained between the demands of the animal organism and the constitution of the food; otherwise either the nutritive or calorifiant system must be deteriorated.

The importance of attention to the proper equilibrium of the constituents of the food is clearly pointed out in the following Table, from which it is evident that food containing

the greatest amount of starch or sugar does not produce the largest quantity of butter, although these substances are supposed to supply the butter; but the best product of milk and butter is yielded by those species of food which seem to restore the equilibrium of the animals most efficiently; and it is also worthy of remark, that it is probably owing to the same cause that an excess of grain yields a smaller product than when a proper admixture of more calorifiant food is present.

It is obvious from this view of the subject that an animal is in a parallel condition to a soil from which a certain amount of matter is periodically removed, and which, in order to retain it in its integrity, must be replaced by an equivalent amount of material in precisely the same proportions. The food of the animal thus corresponds with the manure exhibited to the roots of the plant. To lay down therefore a proper system of dieting for all conditions of the system under exercise and rest, &c., it would be necessary to make a series of experiments upon the animal system corresponding in extent with the analyses of the ashes of plants.

In the following Table, the first column represents the food used by two cows; the second column gives the mean amount of milk yielded by the two animals during five days; the third exhibits the butter during periods of five days; while the fourth contains the quantity of nitrogen in the food taken by both animals during the same periods.

Table VI.

	Milk in 5 days.	Butter in 5 days.	Nitrogen in food in 5 days.
	lbs.	lbs.	lbs.
1.—Grass	114	3·50	2·32
2.—Barley and hay . . .	107	8·43	3·89
3.—Malt and hay . . .	102	3·20	3·34
4.—Barley, molasses and hay .	106	3·44	3 82
5.—Barley, linseed and hay .	108	3·48	4·14
6.—Beans and hay . . .	108	3·72	5·27

We may infer from these results that grass affords the best products, because the nutritive and calorifiant constituents are combined in this form of food in the most advantageous relations. The other kinds of food have been subjected to certain artificial conditions, by which their equilibrium may have been disturbed. In the process of hay-making, for example, the colouring matter of the grass is either removed or altered; a portion of the sugar is washed out or destroyed by fermentation; while certain of the soluble salts are removed by every shower of rain which falls during the curing of the hay. Perhaps similar observations are more or less applicable to the other species of food enumerated.

The principles, which it has been the object of this paper to explain, being understood, little difficulty will be experienced in constructing dietaries so as to meet the wants of the animal system under the particular circumstances in which it may be placed, either when vegetable food is alone used, or when it is desirable to employ also animal food. By various mixtures of one kind of flour less supplied with azotized matter, with another which is richer in this material, the equilibrium of the food which, from meteorological causes prevailing in any particular country, may not have reached the proper standard, may be effectually restored. The wheat flour of England, for example, is inferior to that of the continent of Europe and of America, as appears from Table IV. It may, however, be improved by an admixture either with foreign flour, or with oatmeal, barley, beans, or any of those substances which stand above it in the Table; and in this state it will be found to form a palatable and well-raised bread. All of these species of grain owe their nutritive properties to the presence of fibrin, casein, glutin, and albumen. It is in the predominance of glutin over the other azotized materials that wheat owes its superior power of detaining the carbonic acid engendered by fermentation, and thus communicating to it the vesicular, spungy structure, so characteristic of good bread. By mixing one-third of Canada flour with two-thirds of maize, a very good loaf is produced; and

when equal parts of flour and of oatmeal, or of barleymeal, or of peasemeal, are employed, a palatable bread is the result. Beneficial effects would probably follow from the admixture of two or three different kinds of grain; and many of these forms of bread might be substituted with advantage for pure wheat bread in peculiar conditions of the system.

The preceding observations lead to an extensive field of experiment and deductions of a highly practical nature, and may assist in indicating the direction in which the physician should pursue his inquiries when studying the laws by which the animal system is to be retained in a state of health.

DONATIONS

TO THE

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1845-6.

*** Those works which have been presented by their respective Authors are distinguished by an Asterisk.

ARNOTT, JAMES M., F.R.S.

Correspondence on the subject of the "Eclair," and of the Epidemy which broke out in the said vessel. 1846.

BASSOW, BASILIUS.

*De Urolithiasi et Lithotomia Perinæali. Mosquæ, 1841.

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